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Rosen, S. (1988) Biology Workshop 3 - Middle School
 REVISION

Globe Book Co, New Jersey

AIM | What is reproduction?

1

Almost everywhere you look, you see living things. Plants and animals are living things. They come in all sizes and shapes. Some are huge—like elephants, whales, and giant trees. Some, like ants, fleas, and blades of grass, are much smaller. Tiny bacteria are smaller still. You need a microscope to see them.

Plant or animal, large or small, every living thing must do certain things to stay alive. We call these activities the *life functions*.

Getting food is a life function. So is breathing. Growing and moving are still other life functions.

Living things carry on these life functions to stay alive. But living things also *reproduce*. *Reproduction* means creating new life. Having a baby is reproduction. So is the production of a new blade of grass from a tiny seed.

Living things reproduce living things like themselves. The newborn are called the *offspring*. You are the offspring of your parents. A litter of kittens is the offspring of a cat.

A single organism can live a full life without reproducing. But what would happen if all the animals or plants of one kind did not reproduce? That kind or species [SPEE sheez] of animal or plant would die out. It would become extinct [ik STINGKT].

LIVING THINGS REPRODUCE ONLY THEIR OWN KIND

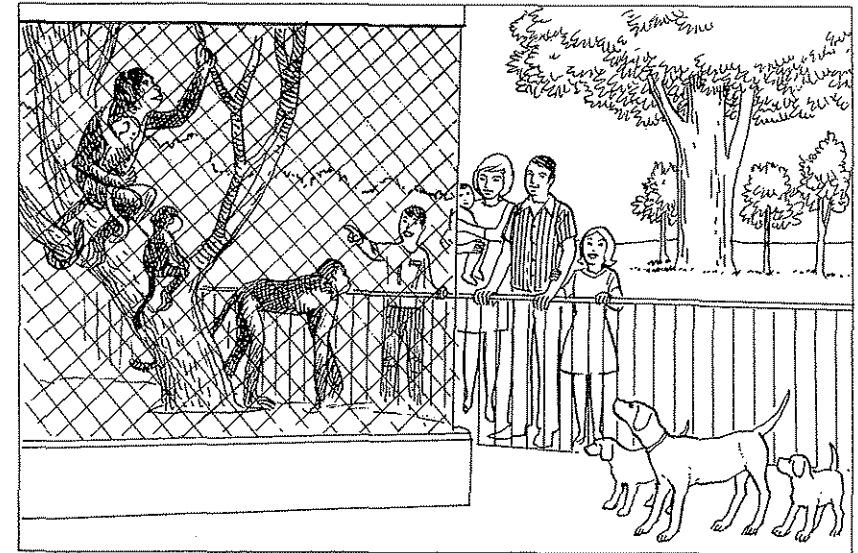


Figure A

Dogs reproduce only dogs. Monkeys reproduce only monkeys. Humans reproduce only humans. Oak trees reproduce only oak trees.

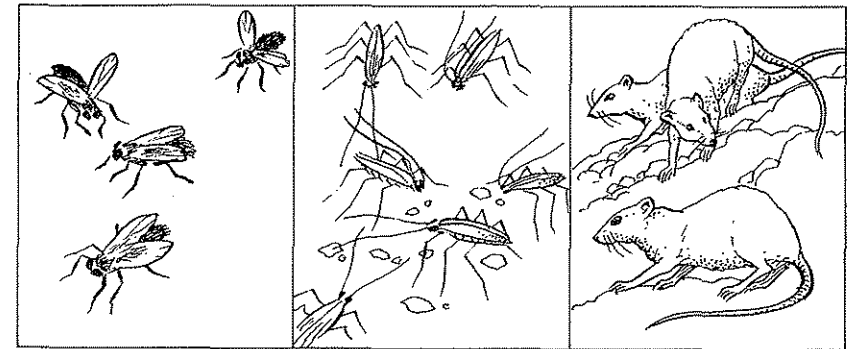


Figure B

Many animals produce a great number of offspring. Sometimes the offspring are unwanted by or even harmful to humans. Many carry disease. They must be controlled.

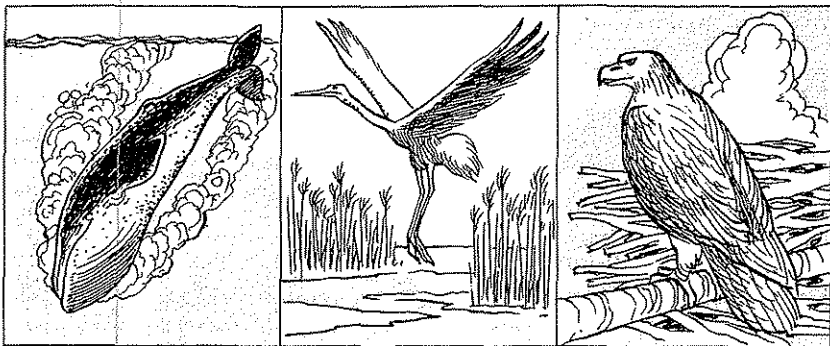


Figure C

Many animals produce only a few offspring in an entire lifetime. These animals must be protected. Otherwise they will become extinct.

WHERE DO LIVING THINGS COME FROM?

At one time many people thought that living things could come from dead (once alive) or nonliving (never alive) matter.

People thought that geese could spring out from shell-like animals on rocks.

People even thought that maggots (small wormlike organisms) came from decaying meat.

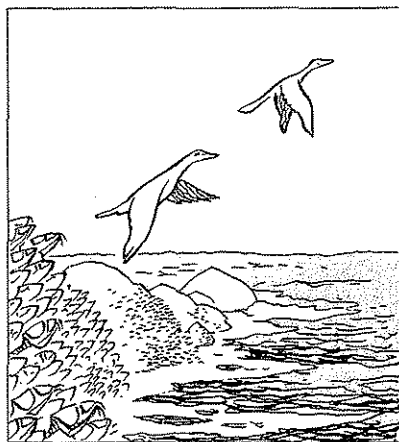
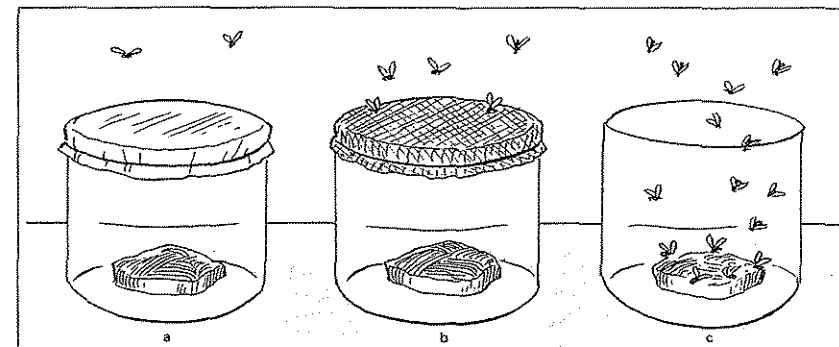


Figure D

Francesco Redi was an Italian scientist. He did not think that maggots came from meat. He thought that living things could only come from living things. He did an experiment to prove this.

REDI'S EXPERIMENT

Redi knew that maggots are often found on decaying meat. He also knew that flies were attracted to the smell of the decaying meat. Redi used three large jars in his experiment. He placed a piece of decaying meat in each.



One jar was capped airtight. One jar was covered only with cheesecloth. One jar was left open.

Figure E

What Redi Saw

1. Flies hardly ever flew to the airtight jar.
2. Flies flew to the cloth-covered jar. But they could not reach the meat.
3. Flies flew into the open jar. They laid their eggs there.
4. Maggots developed only in the open jar.

What Redi Reasoned and Concluded

See if you can reason like Redi did. Choose the letter that best completes the sentence. Write it in the answer blank on the right.

1. The flies could smell the meat that was
 - a) in the open container only.
 - b) in the open container and in the cloth-covered container.
 - c) in the airtight container.
 1. _____
2. The flies could not smell the meat that was
 - a) in the open container only.
 - b) in the open container and in the cloth-covered container.
 - c) in the airtight container.
 2. _____

3. Flies rarely flew to the airtight jar because the flies could not
a) see
b) feel
c) smell
the meat. 3. _____
4. The flies went to the jars they could
a) see.
b) smell.
c) feel. 4. _____
5. The flies were able to get into the jar that was
a) open.
b) closed.
c) cloth-covered. 5. _____
6. The flies laid their eggs only on the meat in the jar that was
a) open.
b) closed.
c) cloth-covered. 6. _____
7. Maggots developed only where
a) the meat was decaying.
b) the flies had laid their eggs.
c) the flies had not laid their eggs. 7. _____
8. Decaying meat is matter that is
a) living.
b) nonliving.
c) dead. 8. _____
9. Flies are
a) living
b) nonliving
c) dead
matter. 9. _____
10. Life
a) can
b) cannot
come from eggs. 10. _____

11. The maggots came from the
a) meat.
b) eggs.
c) jar. 11. _____
12. When the eggs hatched they became
a) maggots.
b) flies. 12. _____
13. Eventually the maggots would become
a) eggs.
b) flies. 13. _____
14. Life comes only from matter that is
a) dead.
b) living.
c) not living. 14. _____

COMPLETING SENTENCES Complete the sentences with the choices below.

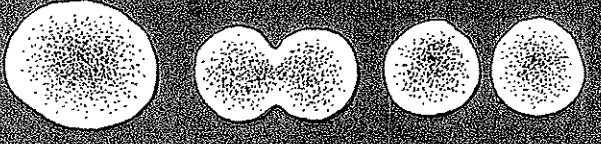
animal	reproduction	life
nonliving	plant	Redi
flies	offspring	life functions
their own kind	mice	dead
birds		whales

1. A living thing may be a _____ or an _____.
2. Living things carry on activities called the _____.
3. The life function that produces new life is _____.
4. Living things reproduce only _____.
5. All life comes from other _____.
6. Life cannot come from _____ or _____ things.
7. The scientist who showed that life comes from other life was _____.
8. A "newborn" is called an _____.
9. Animals like _____ and _____ produce many offspring.
10. Animals like _____ and _____ produce only a few offspring.

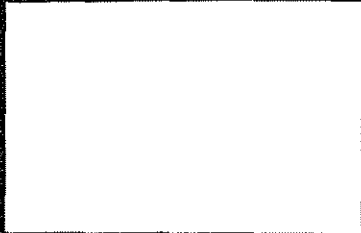
WORD Unscramble each of the following to form a word or term that
SCRAMBLE you have read in this Aim.

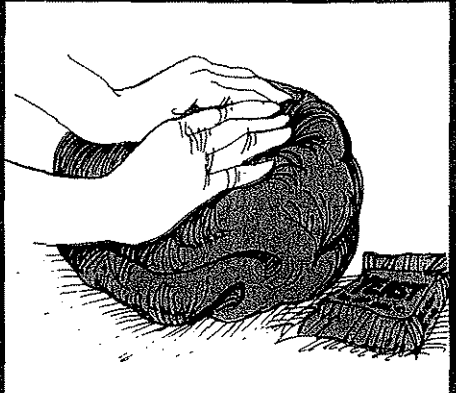
1. GRIFPONSF _____
2. TRUCDROOPNIE _____
3. FILE _____
4. TEXTICN _____
5. DIER _____

WHAT IS BINARY FISSION? WHAT IS BUDDING?

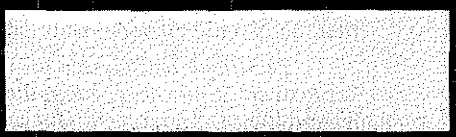


2









sexual reproduction: reproduction from two parents

asexual reproduction: reproduction from one parent

binary fission: a kind of asexual reproduction; bacteria reproduce by fission

budding: a kind of asexual reproduction; yeast cells reproduce by budding

AIM | What is binary fission?

2 | What is budding?

You have a mother. You also have a father. You have two parents—one male and one female.

Your dog or cat has two parents also. So does a fly, snake, or fish. In fact, most living things you can name came from two parents.

Reproduction from two parents is called *sexual reproduction*.

There is another kind of reproduction that comes from one parent. Reproduction from only one parent is called *asexual reproduction*.

BINARY FISSION There are several kinds of asexual reproduction. The simplest kind is called *binary fission* [BY na ree FISH un]. Bacteria and simple one-celled plants and animals reproduce by binary fission.

This is the way binary fission works:

- The simple one-celled organism grows until it reaches full size.
- Then it divides evenly. It becomes two “daughter” cells.

Each daughter cell is exactly alike. It is also exactly like the parent cell was—only one half the size.

Each new cell carries on its own life functions. It eats. It breathes. It grows. It grows until it reaches full size. Then it reproduces.

This process of growth and reproduction goes on and on.

BUDDING Another form of asexual reproduction is called *budding*. Budding produces two cells of *different* sizes.

Several kinds of organisms reproduce by budding. Yeast is the most common. Yeast is a microscopic plant. It is made of one colorless cell.

In budding, a tiny organism grows out from the parent cell. When it is large enough it breaks off from the parent cell. It grows until it is able to reproduce.

UNDERSTANDING BINARY FISSION

Look at Figures A, B, and C. Answer the questions with each one.

Bacteria are tiny organisms. They reproduce by binary fission.

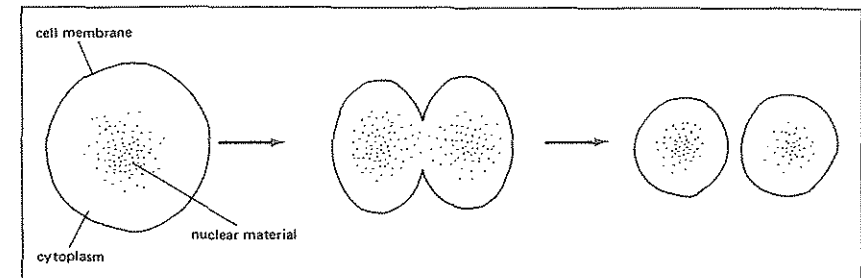


Figure A

A single bacterium [bak TEE ree um] reproducing by binary fission

1. What are the three parts of a bacterium? _____

2. How much of the parent's nuclear material does each daughter cell get?
_____ one-half, one-quarter, all of it
3. How much of the parent's cytoplasm does each daughter cell get?
_____ one-half, one-quarter, all of it

The paramecium and the amoeba are simple one-celled animals. They are microscopic in size. Simple one-celled animals are called *protozoa*. Protozoa reproduce by binary fission, too.

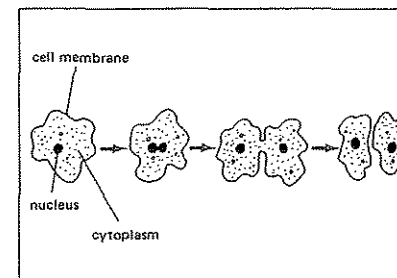


Figure B

An amoeba reproducing by binary fission

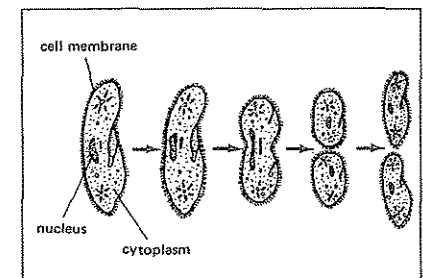


Figure C

A paramecium reproducing by binary fission

4. What are the three parts of the cells shown in Figures B and C?

5. How much of the parent's nucleus does each daughter cell get?

6. How much of the parent's cytoplasm does each daughter cell get?

7. Are the daughter cells exactly alike? _____
8. Daughter cells are exactly like the parent cell, except in one way. What is it?

9. What kind of reproduction is binary fission? _____
sexual, asexual
10. How many parents take part in binary fission? _____

UNDERSTANDING BUDDING

Figure D shows a budding yeast cell. Read the explanation and answer the questions.

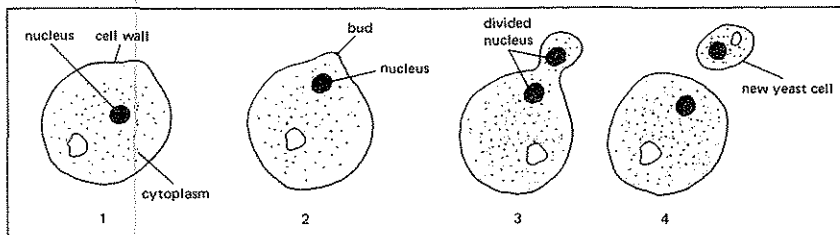


Figure D A budding yeast cell

- When a yeast cell "buds," part of its cell wall bulges. This bulge is the start of a bud (1).
- The nucleus moves towards the bud (2).
- The nucleus divides evenly. Now there are two nuclei [NOO klee eye]. One nucleus moves into the bud. The other nucleus stays in the parent cell (3).

■ The bud grows larger and larger. When it is large enough, it breaks off from the parent cell. The bud is now on its own (4).

■ The new yeast cell carries on the life functions. It gets food and grows. When it is large enough, it will reproduce by forming a bud, too.

1. In budding, the nucleus _____
divides in half, divides unevenly
2. One nucleus stays in the parent cell. The other moves _____
into the bud, out of the bud
3. The amount of cytoplasm in the parent cell is _____ the amount
in the bud.
more than, less than
4. Budding is a kind of _____ reproduction.
asexual, sexual
5. How many parents take part in budding? _____

COMPLETING SENTENCES Complete the sentences with the choices below.

different
sexual
protozoa
binary fission

plant
the same
asexual
budding

reproduction
one-celled
bacteria

1. Creating new life is called _____.
2. Reproduction that needs two parents is called _____ reproduction.
3. Reproduction that needs one parent is called _____ reproduction.
4. The simplest kind of asexual reproduction is called _____.
5. Two kinds of organisms that reproduce by binary fission are _____
and _____.
6. Protozoa are simple _____ organisms.
7. Yeast cells are one kind of simple one-celled _____.
8. Yeast cells reproduce by _____.
9. Binary fission produces cells of _____ size.
10. Budding produces cells of _____ sizes.

THROW ONE OUT In each of the following set of terms, one of the terms does not belong. Circle that term.

1. sexual reproduction asexual reproduction one parent
2. sexual reproduction asexual reproduction two parents
3. protozoa binary fission budding
4. binary fission bacteria yeast
5. binary fission budding yeast

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

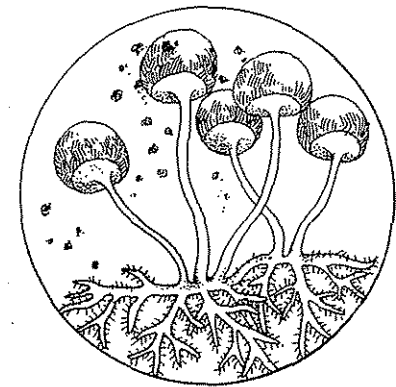
1. _____ Producing new life is called respiration.
2. _____ Only animals reproduce.
3. _____ Dogs, cats, and humans reproduce from two parents.
4. _____ Reproduction from two parents is called sexual reproduction.
5. _____ Reproduction from one parent is called asexual reproduction.
6. _____ Bacteria, protozoa, and yeast reproduce by sexual reproduction.
7. _____ Binary fission is a form of asexual reproduction.
8. _____ Binary fission produces offspring of the same size.
9. _____ Budding is a form of sexual reproduction.
10. _____ Budding produces offspring of the same size.

REACHING OUT

1. When a bacterium reproduces, two daughter cells are produced.
How many more bacteria is this than started out? _____
2. Under proper conditions, bacteria reproduce every 30 minutes.
 - a) If you start out with one bacterium, how many bacteria will you have after one hour? _____
 - b) How many will you have after two hours? _____
 - c) How many will you have after twenty-four hours? _____

WHAT ARE SPORES?

3



spore: tiny plant cell that can grow into a new plant

AIM | What are spores?

3

Have you ever seen "fuzz" growing on old bread? Then you've probably seen bread mold. Mold is a many-celled plant. It is in the same family as yeast. But mold does not reproduce by budding like yeast does. Mold reproduces by special reproductive cells called spores.

The cells of a mold plant form many thread-like branches. Some of the branches are like roots. They grow down into the food the mold takes in.

Other branches grow straight up. At the end of each of these straight branches is a tiny ball. The ball, or spore case, contains thousands of spores. A mold spore is a special cell that can reproduce other mold plants. (Remember, living things reproduce their own kind.)

When a spore case grows to full size, it bursts open. The spores fly into the air. They are very light in weight and are carried by the slightest air movement. Spores fall on everything. They are on you and everything around you.

Spores land on bread and other foods. If the temperature and moisture are right, the spores grow. They grow into new mold plants.

Other organisms, like mushrooms, also reproduce by spores. Reproduction by spores is still another form of asexual reproduction. It is the simplest kind of reproduction that uses special reproductive cells.

UNDERSTANDING SPORES

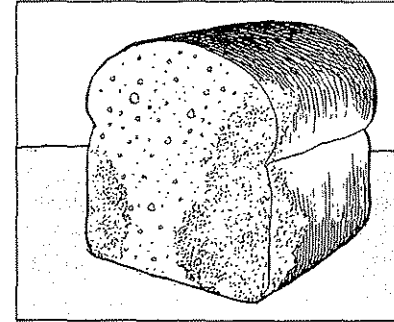


Figure A

Bread mold looks like this.

Bread mold is fuzzy. At first it is white. Then it changes to gray and then to black.

Mold gives off a bad odor.



Figure B

This is what mold looks like under a microscope.

Mold is thread-like.

Some threads grow into the bread and take in food.

The other threads grow straight up.

At the end of each upright thread is a spore case.

A spore case holds thousands of special cells called spores. Each spore can reproduce into a new mold plant.

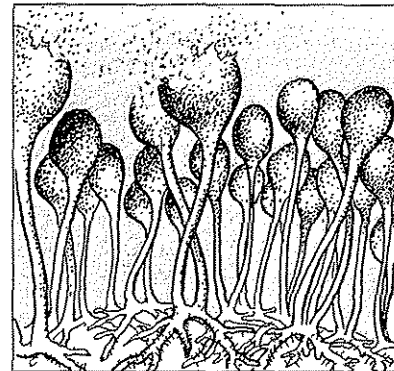


Figure C

When a spore case grows to full size it bursts open.

The spores travel through the air. They land on everything.

The spores that land on food can reproduce into new mold plants. They reproduce if the temperature and moisture are right.

COMPLETING SENTENCES

Complete the sentences with the choices below. One of these may be used three times.

budding
feed
mold plant
many

fuzzy
moisture
food
spore case

binary fission
temperature
thread-like
spores

- Three kinds of asexual reproduction are _____, _____, and reproduction by _____.
- The simplest kind of reproduction that uses *special reproductive cells* is reproduction by _____.
- A mold is a simple _____-celled plant.
- Without a microscope, a mold looks _____.
- Under a microscope we see that a mold is made up of many _____ branches.
- Mold branches that grow down into food _____ the mold plant.
- Each branch that grows upward has a _____ on the end.
- A spore case contains thousands of _____.
- A single mold spore can reproduce into a new _____.
- A mold spore can reproduce into a new mold plant if it lands on _____, and if the _____ and _____ are right.

IS A SPORE A SEED?

A spore is not a seed.

A seed is made by two parents—one male and one female.

A spore is made by one parent that has no sex.

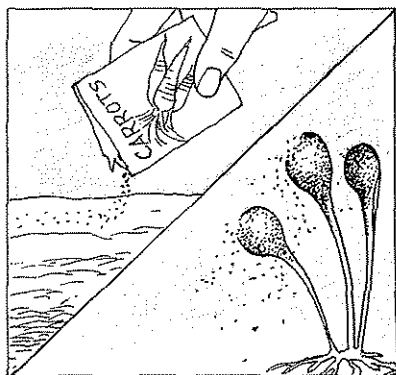


Figure D

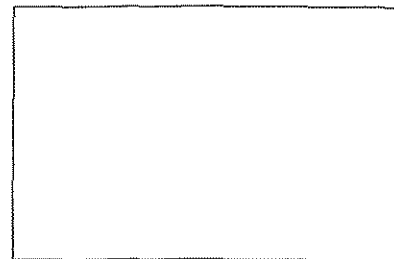
GROWING YOUR OWN MOLD

What You Need a small piece of bread
paper towel
small jar and cap
water

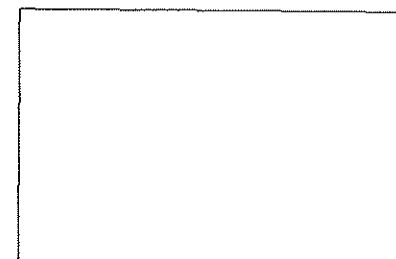
What To Do

- Fold the paper towel in half and in half again.
- Cut a piece of the towel to fit in the bottom of the jar.
- Pour a small amount of water into the jar—just enough to wet the towel completely.
- Wipe the bread across dust. (Every house has dust.) Try the top of a closet—the top of a door—any open place that you don't get to often.
- Place the bread on the moist paper—dust side up.
- Cap the bottle *loosely*. This is very important!
- Place in a dark place where it is not cold.
- Look at it every day for a week.

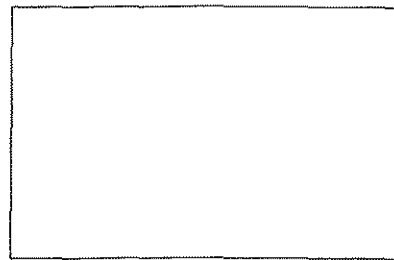
Draw pictures in the boxes below showing how your mold looked as it was growing.



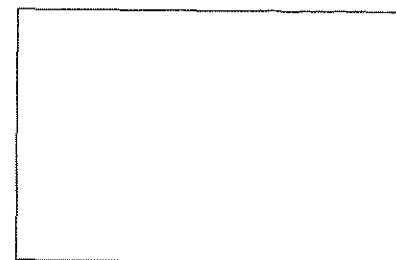
After 2 days



After 4 days



After 6 days



After 8 days

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Reproduction by spores is a form of asexual reproduction.
2. _____ Molds reproduce by spores.
3. _____ A mold is a green one-celled animal.
4. _____ A mold plant makes its own food.
5. _____ A mold has many thread-like branches.
6. _____ Mold branches that grow downward feed the mold.
7. _____ A spore case contains seeds.
8. _____ Mold spores can reproduce yeast cells.
9. _____ Spores are very tiny.
10. _____ Every mold spore grows into a mold plant. (Think about this carefully!)

REACHING OUT

1. Name three things that a spore needs to grow.

2. Do you think a seed needs the same things to grow? _____

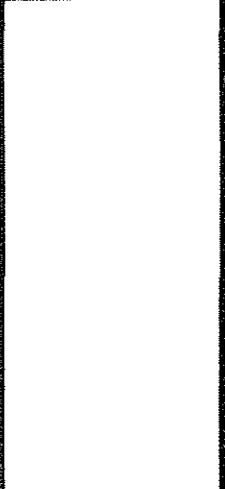
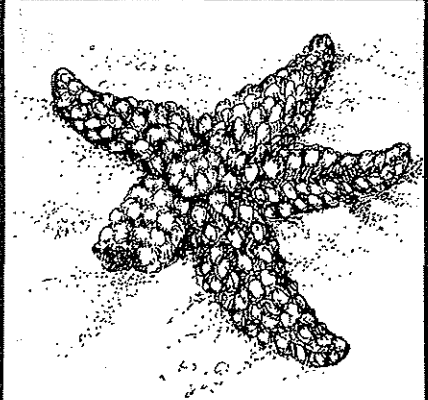
WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

1. ROSEP _____
2. DOLM _____
3. ZYFUZ _____
4. ARDEB _____

WHAT IS REGENERATION?



4

regeneration: the growing back of damaged or lost parts of an organism

planaria: flatworms

AIM | What is regeneration?

4

You cut your finger—and it heals. You clip your dog's fur—and it grows back. You mow the grass—and by next week it needs mowing again!

Every organism undergoes a certain amount of "wear and tear." Each organism can repair itself in some way. New cells grow to replace damaged or lost cells.

The ability of living things to repair themselves is called *regeneration* [ree jen uh RAY shun].

Plants generally have greater powers of regeneration than animals do. For example, an African violet plant will grow from just one leaf.

Regeneration in animals varies greatly. Some have a great ability to regenerate. Others do not. How much an animal can regenerate depends upon how simple or complicated that animal is.

For example, the starfish is a simple animal. It usually has five arms. If just one arm is cut off along with part of the center, a *whole new animal* will grow from that arm. Starfish are made of only a few kinds of cells. So, if a few cells are left alive they can regenerate the missing ones.

If an organism can regenerate a whole organism from one part it shows a type of *asexual reproduction*.

Other groups of animals are a little bit more complicated. They are made of many more kinds of cells. But some of these animals can regenerate parts of their bodies that are lost. For example, a lobster or crab can grow a new claw.

Regeneration in complicated animals is very limited. Mammals (like humans) can regenerate only skin, nails, hair, and certain other tissues. Mammals cannot regenerate whole parts—like an arm or a leg.

STARFISH REGENERATION

Figures A and B show starfish regeneration. Look at the figures and answer the questions.

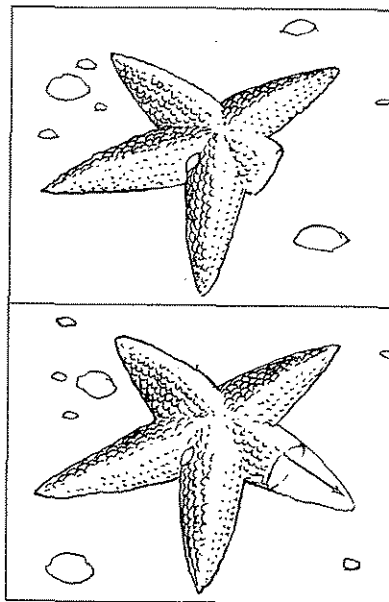


Figure A

A starfish can regenerate lost arms. A starfish can do even more.

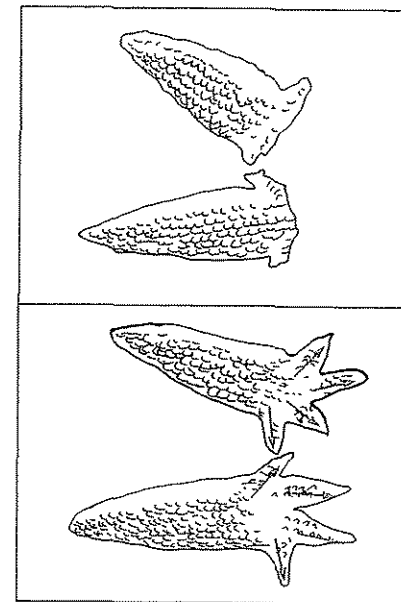


Figure B

A starfish can regenerate a complete starfish from just one arm and part of the center.

1. Can more than one starfish regenerate from just one five-arm starfish?

2. a) Which figure is showing a form of asexual reproduction? _____

A, B

- b) Explain your answer. _____

3. a) Which figure is showing only cell repair? _____

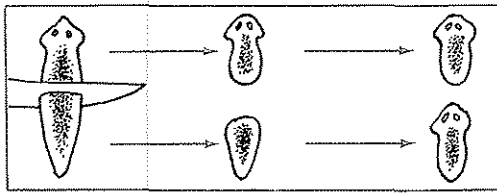
A, B

- b) Explain your answer. _____

HEADS OR TAILS?

A planarian [pluh NAIR ee un] is a tiny flatworm. It lives in ponds.

If a planarian is cut into pieces, it will regenerate its missing parts.



It can be cut in half across its body. The head portion will grow a new tail. The tail portion will grow a new head.

Figure C

The way a planarian regenerates depends upon how it is separated. This happens in nature, but it can also be done in the laboratory.

Figure D shows four planaria. Each one was separated in a different way. (The dotted lines show the separations.)

Figure E shows four groups of regenerated planaria.

Which planarian regenerated into which group? Answer by placing the correct number on the line.

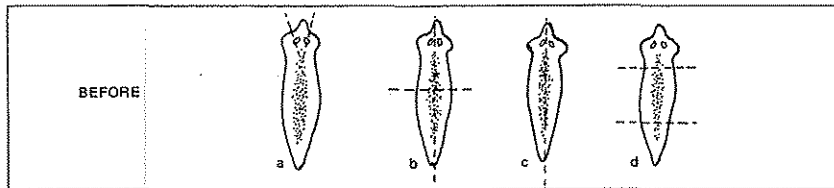


Figure D

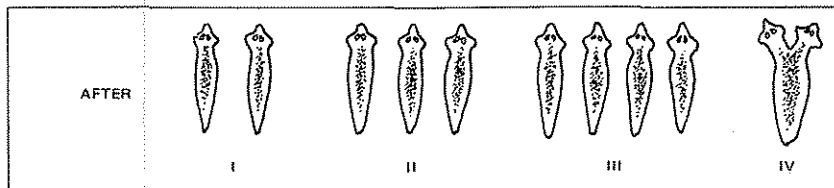
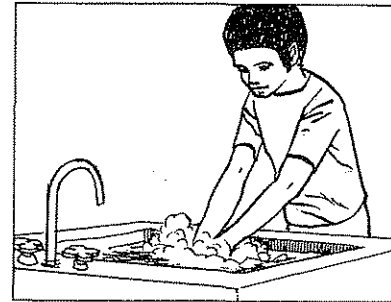


Figure E

1. Planarian a became group _____.
2. Planarian b became group _____.
3. Planarian c became group _____.
4. Planarian d became group _____.

SOME INTERESTING ANIMAL REGENERATIONS



Every day billions of your body cells die.

Every time you wash your hands, you wash off hundreds—even thousands—of skin cells.

New skin cells are always being regenerated.

Figure F

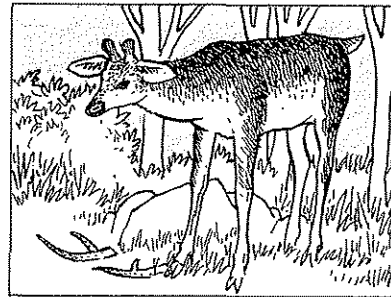


Figure G

A deer sheds its antlers every year. New ones grow back.

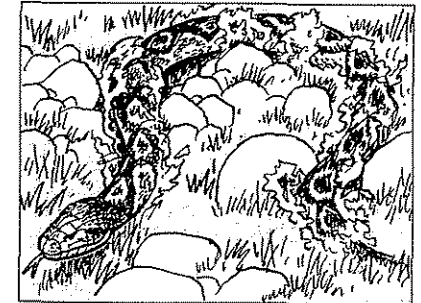


Figure H

A snake sheds its skin every year. Under the old skin, new skin has grown.



Figure I

The glass lizard escapes from its enemies by breaking off the end of its tail. Later, a new tail will grow.

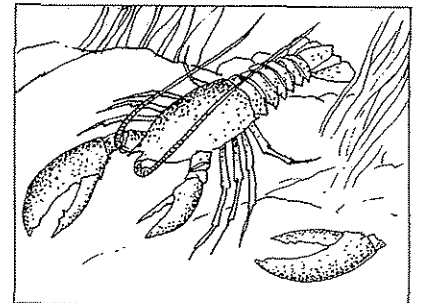


Figure J

If a lobster or crab loses a claw to an enemy, it will grow a new one.

COMPLETING SENTENCES

Complete the sentences with the choices below. One of these may be used twice.

nails
simple
lobster
asexual reproduction
plants

starfish
crab
skin
complicated
dogs

whole parts
regeneration
people
hair
planarian

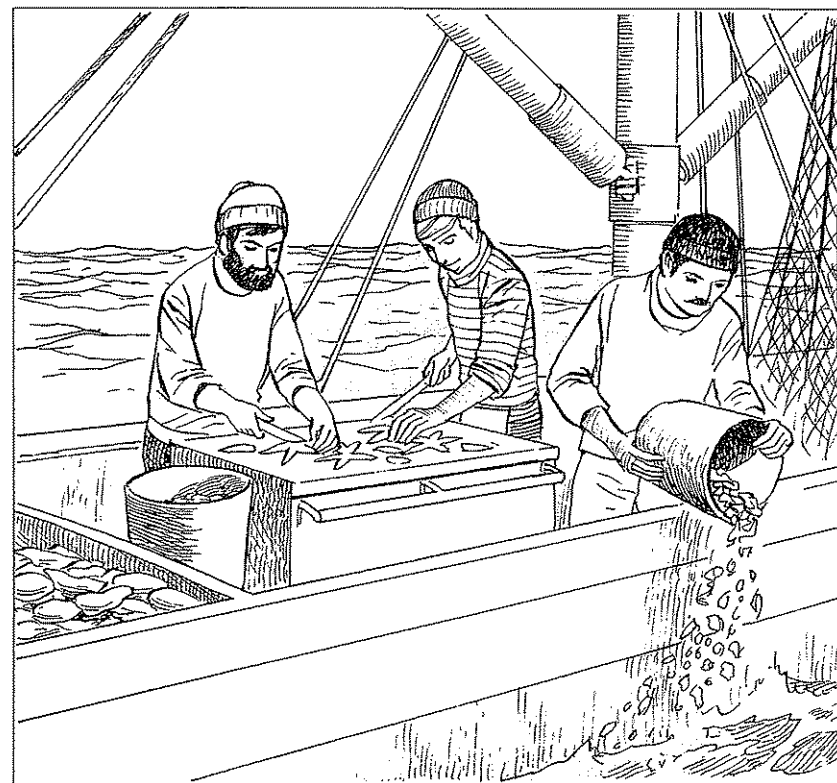
1. Body "repair" is called _____.
2. Generally, _____ have the greatest powers of regeneration.
3. In animals, regeneration power greatly depends upon how _____ or how _____ the animal is.
4. Mammals are _____ forms of animals.
5. Examples of mammals are _____ and _____.
6. Mammals can regenerate tissues like _____, _____, and _____.
7. Mammals cannot regenerate _____.
8. Two simple animals that can regenerate a complete animal from just a part are the _____ and the _____.
9. Animals like the _____ and _____ can grow certain whole parts. But they cannot regenerate a whole organism from just a part.
10. Regeneration that forms a whole organism from just a part is said to be a kind of _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--------------------------------|------------------------------------|
| 1. _____ mammals | a) can regenerate from parts |
| 2. _____ planaria and starfish | b) body repair |
| 3. _____ regeneration | c) have many kinds of cells |
| 4. _____ asexual reproduction | d) reproduction by only one parent |

REACHING OUT



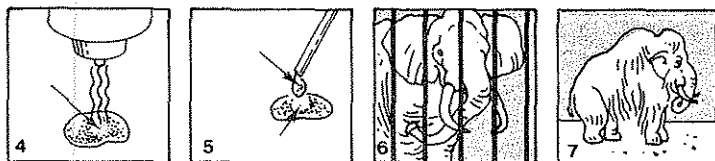
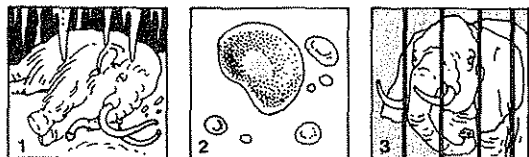
This is a true story!

Starfish feed on oysters. At one time, oyster fishermen tried to kill the starfish. They scooped the starfish up from their oyster beds. They chopped them up and dumped the pieces back into the water.

What do you think happened?

Finish the story in your own words.

KEEPING UP WITH SCIENCE



BACK FROM EXTINCTION

The hairy or woolly mammoth was a huge elephantlike creature. It is now extinct. The mammoth died out during the last Ice Age, about 10,000 years ago. Yet some day you may be able to see a live mammoth in a zoo. Let's see why.

Every cell of an organism contains the blueprint needed to produce an exact copy of that organism. Why? Because every cell contains all the genes for that particular species. Perhaps only one undamaged cell can produce an entire organism.

The process of creating an offspring from a single cell is called **cloning**. The identical offspring is called a **clone**.

The woolly mammoth lived in regions where there were glaciers. Occasionally one would fall into a crevasse and be frozen to death. Over the years, at least 36 preserved mammoths have been found in glaciers.

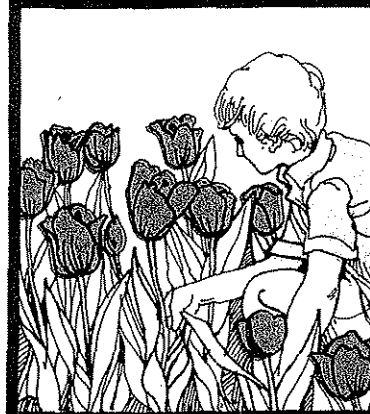
You know that instant freezing preserves tissue. But for how long? For ten thousand years? Possibly. The mammoths

that have been found were embalmed for further preservation. And the embalming chemicals destroyed the cells. Russian scientists hope to find another frozen mammoth. They will keep it frozen until they return to their laboratory. There they plan to thaw it out carefully. Hopefully, they will find some undamaged cells. Then they will attempt to clone them. This is how they plan to do it:

1. A well-preserved mammoth is found.
2. The frozen cells are carefully thawed out. Cells are grown in the laboratory.
3. A fertilized egg is taken from a female elephant.
4. The nucleus of the elephant egg is destroyed by radiation.
5. The nucleus from a mammoth cells is transplanted into the elephant egg.
6. The egg is transplanted into the womb of the elephant.
7. The elephant is now pregnant. It gives birth to a baby woolly mammoth.

WHAT IS VEGETATIVE PROPAGATION?

5



vegetative propagation: the asexual reproduction of plants

bulb: a short underground stem surrounded by thick colorless leaves

tuber: a heavy underground stem

AIM | What is vegetative

5 | propagation?

Plants are important to everyone. We cannot live without them. Plants give us oxygen and food. Many plants look pretty and smell nice. They can make our lives more pleasant.

Plants are living things. Therefore, they reproduce. Many plants reproduce from seeds. Many reproduce without seeds.

Reproduction from seeds is sexual reproduction. Reproduction without seeds is asexual reproduction.

Asexual reproduction in plants is called vegetative propagation.

In vegetative propagation, a root, stem, bud, or leaf reproduces one or more new plants.

There are several kinds of vegetative propagation. Some kinds are natural. Other kinds are artificial.

Two kinds of natural vegetative propagation take place by means of bulbs and tubers [TOO berz].

BULBS A bulb is really a short underground stem surrounded by thick colorless leaves. They are special leaves. They do not make food like green leaves do. They store the food made by the green leaves above the ground.

When a bulb is full size, it reproduces. Several "baby" bulbs called *bulblets* grow from the base.

The bulb you know best is the *onion*. Other bulbs are the *tulip* and the *lily*.

TUBERS A tuber is also a heavy underground stem. It stores food made by the green leaves above the ground.

The *white potato* is a tuber. (The *sweet potato* and the *yam* are not tubers.)

A tuber has several "eyes." Each eye is really a bud—a young plant. When a tuber is planted, each bud can sprout into a complete new plant. The same thing can happen if only a part of a tuber is planted. All that is needed is at least one eye.

WHY ARE PLANTS IMPORTANT?

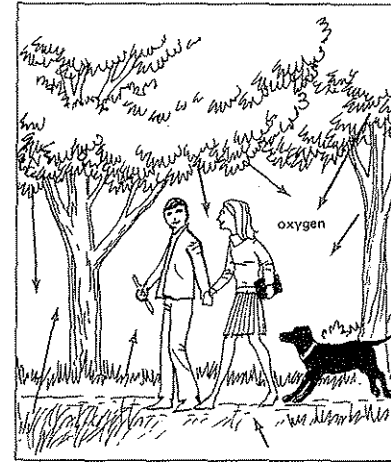


Figure A

Plants give us oxygen.

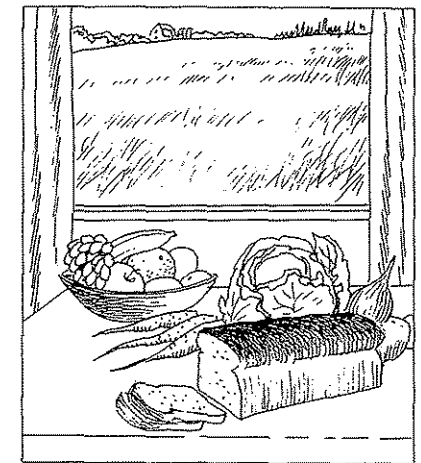


Figure B

Fruits and vegetables are plants that we eat. Flour that comes from plants can be made into bread.

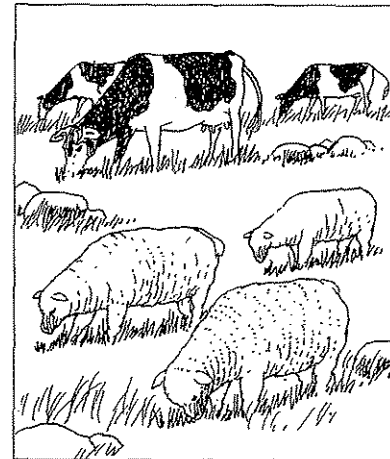


Figure C

Animals like cows and sheep eat plants. Then we eat the meat from these animals.

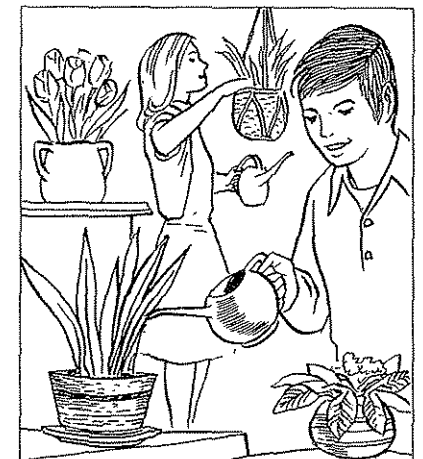


Figure D

Plants can make our surroundings more pleasant.

THE PARTS OF A PLANT

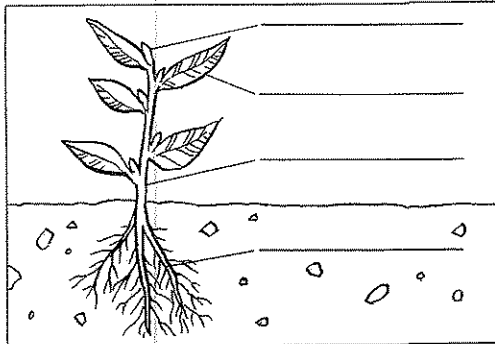


Figure E

Answer the questions.

1. Which part takes in water and minerals? _____
2. Which part supports the plant? (This part sometimes stores food.)

3. A plant makes its own food. Which part makes the food? _____
4. Which part shows new growth? _____

In vegetative propagation, a new plant reproduces from either a root, stem, bud, or leaf.

Can you identify each of these parts? Write the names of these four parts on the proper lines on Figure E.

BULBS AND TUBERS

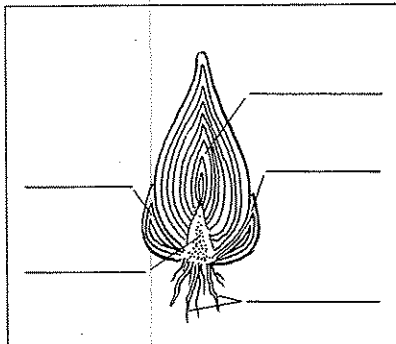


Figure F

Figure F shows the inside of a bulb.

1. Identify the parts listed below. Write the names on the correct lines in Figure F.
roots
stem
colorless leaves
bulblets (2)
2. What is the job of the colorless leaves? _____

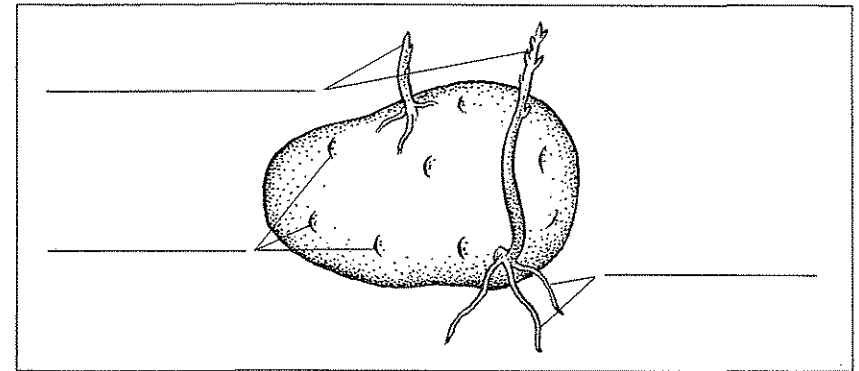


Figure G

Figure G shows a tuber.

3. Identify the parts listed below. Write the names on the correct lines in Figure G.
roots new sprouts eyes
4. What is the job of a tuber?

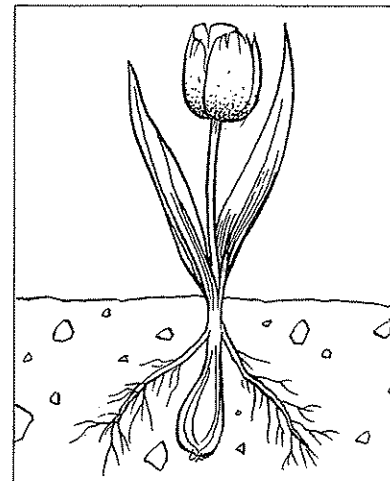


Figure H

Figure H shows what a complete bulb plant looks like.

It has roots, above-ground stems, green leaves, colorless leaves, and a flower.

5. Which part takes in water and minerals? _____
6. a) Which part of the plant makes food? _____
b) Where is this food stored?

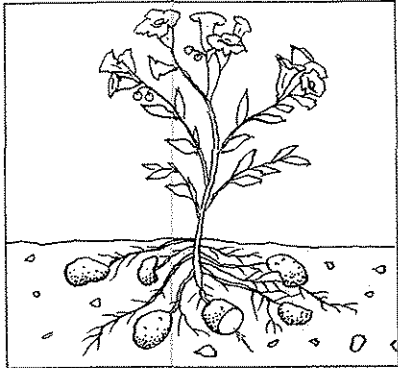


Figure I

This is what a complete potato plant looks like.

It has roots, tubers, above-ground stems, green leaves, and several small flowers.

7. a) Where does a potato plant make its food? _____
- b) Where is this food stored? _____
8. Find the part of a tuber labeled with an arrow. What was it used for? _____

SOMETHING INTERESTING

- Flowers produce fruits.
- Fruits produce seeds.
- Seeds produce new plants.
- Bulb and tuber plants have flowers, fruits, and seeds. Yet, bulb plants are rarely grown from seeds. Potato plants are never grown from seeds!

Why?

These are the reasons:

- The seeds of bulb plants take too long to grow.
- Potato seeds are weak. They rarely grow into plants.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|---|--|
| 1. _____ vegetative propagation | a) a bud |
| 2. _____ tuber | b) short underground stem surrounded by thick colorless leaves |
| 3. _____ tuber eye | c) asexual plant reproduction |
| 4. _____ bulb | d) store food |
| 5. _____ tubers and colorless leaves of bulbs | e) heavy underground stem |

COMPLETING SENTENCES Complete the sentences with the choices below. One of these may be used twice.

onion	store	underground stem
vegetative propagation	eyes	tubers
store food	colorless leaves	bulblet
bulbs		

1. Asexual reproduction in plants is called _____.
2. The two means of vegetative propagation studied in this Aim are _____ and _____.
3. A bulb is really a short _____.
4. A bulb stem is surrounded by thick _____.
5. A bulb's colorless leaves _____ food.
6. A new bulb is called a _____.
7. An example of a bulb is the _____.
8. A tuber is really a thick _____.
9. New tubers grow from the _____ of a parent tuber.
10. The job of a tuber is to _____.

TRUE OR FALSE Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ All plants reproduce from seeds.
2. _____ Reproduction without seeds is sexual reproduction.
3. _____ Vegetative propagation is asexual reproduction.
4. _____ Bulbs and tubers reproduce by vegetative propagation.
5. _____ A bulb is really a short underground flower.
6. _____ The colorless leaves of a bulb store food.
7. _____ A potato is a bulb.
8. _____ A tuber eye is a bud.
9. _____ A whole new plant can grow from the eye of a tuber.
10. _____ Bulbs and tubers have roots and green leaves.

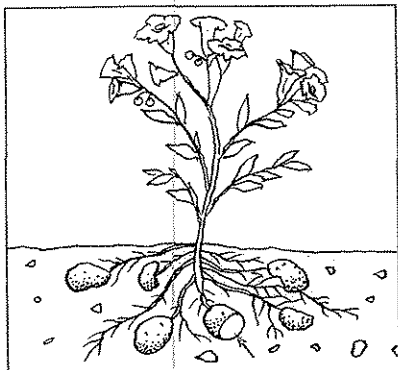


Figure I

This is what a complete potato plant looks like.

It has roots, tubers, above-ground stems, green leaves, and several small flowers.

7. a) Where does a potato plant make its food? _____
- b) Where is this food stored? _____
8. Find the part of a tuber labeled with an arrow. What was it used for? _____

SOMETHING INTERESTING

- Flowers produce fruits.
- Fruits produce seeds.
- Seeds produce new plants.

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COMPLETING SENTENCES Complete the sentences with the choices below. One of these may be used twice.

onion	store	underground stem
vegetative propagation	eyes	tubers
store food	colorless leaves	bulb
bulbs		

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5. _____ A bulb is really a short underground flower.
6. _____ The colorless leaves of a bulb store food.
7. _____ A potato is a bulb.
8. _____ A tuber eye is a bud.
9. _____ A whole new plant can grow from the eye of a tuber.
10. _____ Bulbs and tubers have roots and green leaves.

DO THIS AT HOME

Vegetative propagation is the reproduction of a whole plant from a plant part.

Grow your own whole plants from plant parts. The figure below shows what to do.

Be patient—they will take time to grow.

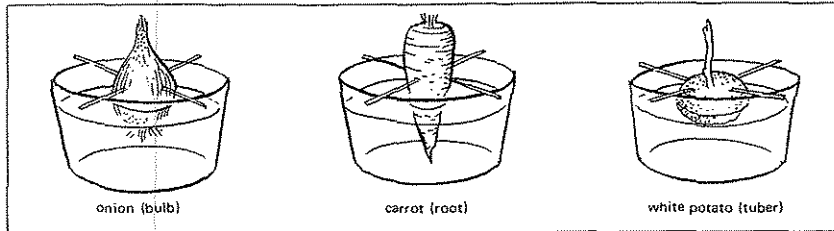


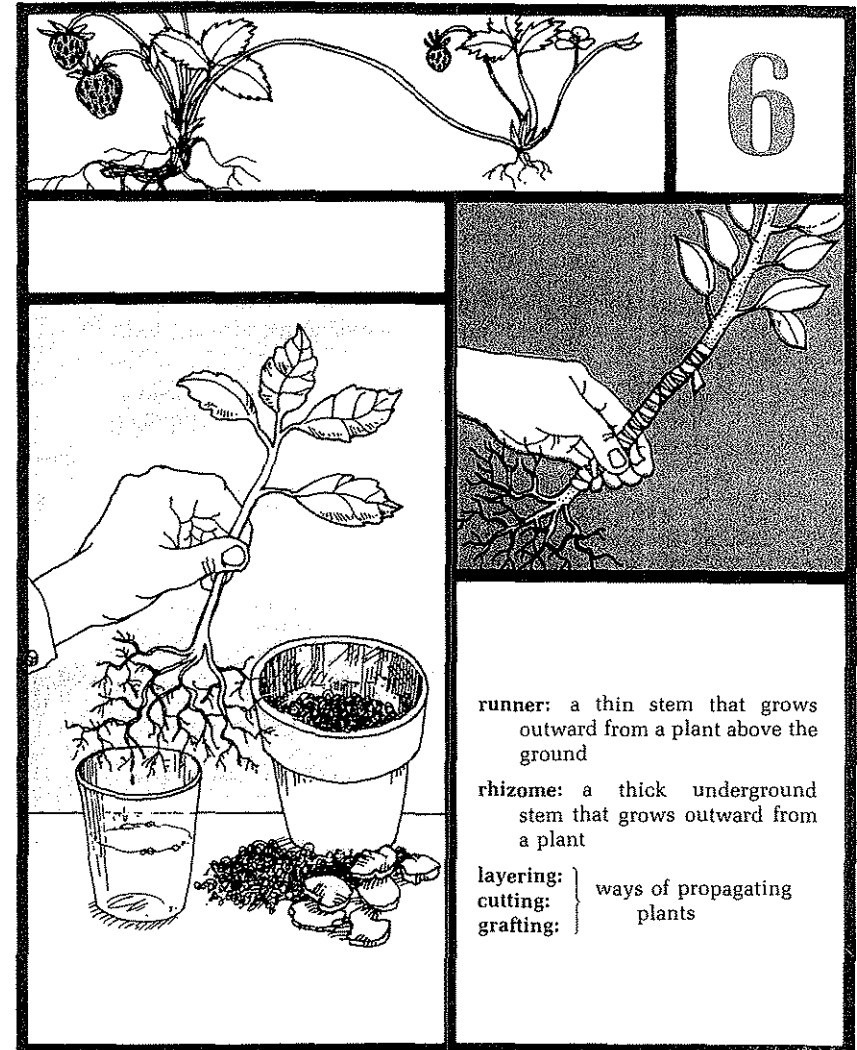
Figure J

WORD SEARCH The words in this list are hidden in the group of letters. Try to find each word. Draw a line around each. The spelling may go in any direction: up-and-down, across, or diagonally.

PROPAGATION
SEXUAL
BULB
EYE
YEAST
OFFSPRING
PARAMECIUM
TUBER
BUD
AMEBA
PLANARIAN
ROOT
FISSION
SPORE

P	A	R	A	M	E	C	I	U	M	F	F	O
A	R	N	A	I	R	A	N	A	L	P	Y	E
R	A	O	M	D	S	M	X	E	T	S	E	A
T	R	F	P	A	U	E	E	Y	E	A	S	T
Y	L	F	E	A	X	B	A	X	D	R	T	U
R	S	S	R	R	G	A	U	P	S	U	E	B
A	E	P	O	O	T	A	M	L	I	P	D	E
G	L	R	P	A	L	E	T	C	B	U	T	R
T	F	I	S	S	I	O	N	I	A	O	E	O
B	E	N	P	L	A	N	E	T	O	M	M	P
Y	P	G	U	B	L	I	M	R	B	N	A	S

WHAT ARE SOME OTHER WAYS OF PROPAGATING PLANTS?



runner: a thin stem that grows outward from a plant above the ground

rhizome: a thick underground stem that grows outward from a plant

layering:
cutting:
grafting: } ways of propagating plants

AIM | What are some other ways 6 | of propagating plants?

Runners, rhizomes [RYE zohmz], and layering are three more ways that plants reproduce naturally without seeds. Cutting and grafting are artificial ways that people can use to reproduce plants.

RUNNERS The main stem of a plant grows straight up. It gives the plant support. Some plants have other kinds of stems, too. They are special reproductive stems called runners. Runners grow outward from the plant and close to the ground (Figure A).

Each runner has a bud. The bud touches the earth and starts a new plant. Strawberry plants reproduce by runners.

RHIZOMES A rhizome is a thick, underground stem (Figure B). It contains stored food. Rhizomes grow outward from a plant.

Rhizomes have swellings called nodes. Nodes develop buds that start new plants. Irises and many ferns reproduce by rhizomes.

LAYERING The upright stems of certain plants are not very stiff. They droop. If a drooped part touches the earth, roots develop and a new plant grows (Figure C).

Layering happens in nature. It can also be done artificially. Rose, raspberry, and blackberry plants reproduce by layering.

CUTTINGS You may have made a cutting from a house-plant yourself. You cut a stem or a leaf from a plant. You placed the cutting in water or in moist soil or sand. In a few days, roots developed and you could plant the cutting.

Geraniums may be grown from stem cuttings. Begonias may be grown from leaf cuttings.

GRAFTING The growing together of a stem cutting of one plant to another plant is called grafting. A plant can be grafted only to another plant that is related.

Grafting is most often done with fruit trees.

REPRODUCTION BY RUNNERS, RHIZOMES, AND LAYERING

Look at Figures A, B, and C. Answer the questions with each.

1. How many runners do you see?

2. The oldest plant is on the

3. The youngest plant is on the

4. Runners grow _____ the ground.

5. A runner is a special kind of

Identify the parts in Figure B by letter.

6. rhizome _____

7. roots _____

8. node _____

9. bud _____

10. new plant _____

11. old plant _____

12. A rhizome is a special kind of underground _____

13. Which side do you think shows natural layering? (Figure C) _____

14. Which side shows artificial layering? _____

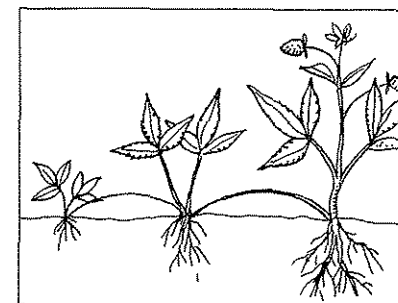


Figure A
A strawberry plant reproduces by runners.

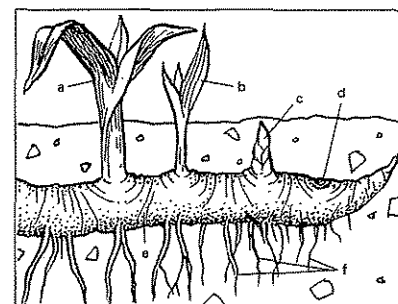


Figure B
An iris plant reproduces by rhizomes.

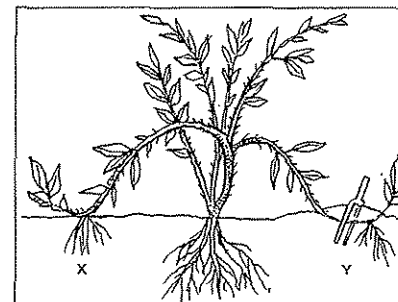


Figure C
A berry plant reproduces by layering. Reproduction by layering can be natural or artificial.

REPRODUCTION FROM CUTTINGS

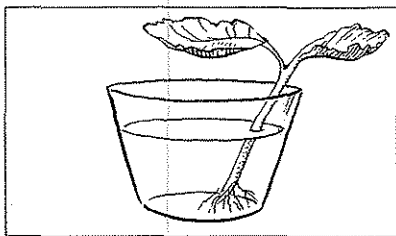


Figure D A stem cutting

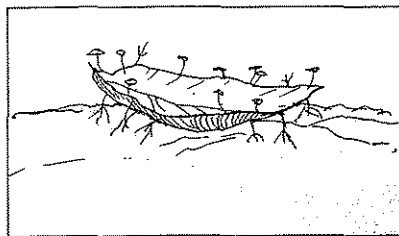


Figure E A leaf cutting

Some plants that reproduce from *stem* cuttings are geraniums, ivy, and many types of grapes. Roses can also be reproduced from cuttings.

In what other way do rose plants reproduce? _____

African violets and some begonias reproduce from *leaf* cuttings.

REPRODUCTION BY GRAFTING

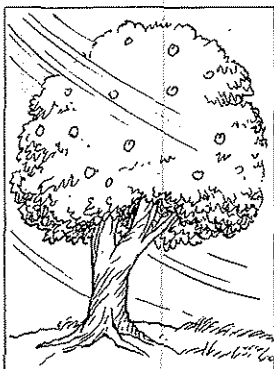


Figure F

The large tree in Figure F is very strong and can live in bad conditions. But the apples from it are small and do not have good flavor.

Branches from apple trees that bear large and tasty apples may be grafted to the strong tree. Figure G shows how it is done.

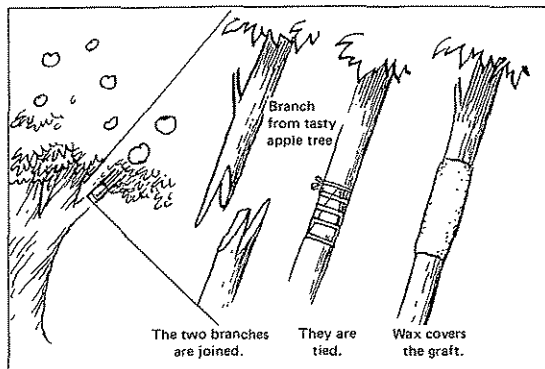


Figure G

COMPLETING SENTENCES Complete the sentences with the choices below. One of these is used twice.

underground
nodes
related
moist

cuttings
full plants
vegetative propagation

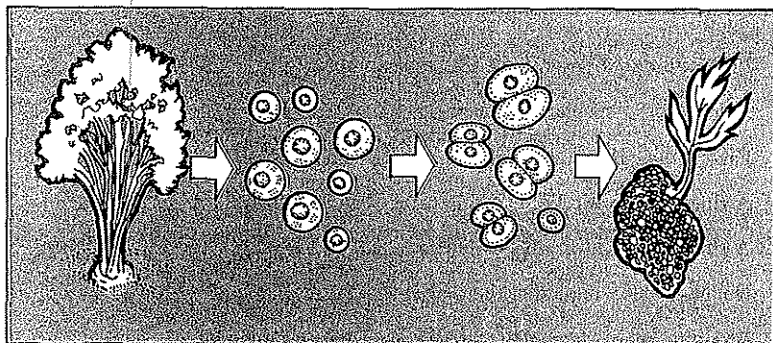
stem
layering
bud

1. Plant reproduction without seeds is called _____.
2. A runner is a special kind of _____.
3. Each runner has a _____ at the end that grows into a full plant.
4. A rhizome is a kind of _____ that grows _____.
5. A rhizome has swellings called _____.
6. Nodes develop buds that then grow into _____.
7. Drooping plant stems may cause a plant to reproduce by _____.
8. Leaves and stems may be used as _____.
9. Cuttings must be kept _____.
10. Grafting is done only with _____ plants.

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Plants reproduce asexually from runners and rhizomes.
2. _____ Runners grow under the ground.
3. _____ Rhizomes grow under the ground.
4. _____ Runners and rhizomes are stems.
5. _____ All stems grow upward.
6. _____ Stiff plants reproduce by layering.
7. _____ Cuttings and grafting are natural means of reproduction.
8. _____ A cutting may be a stem or a leaf.
9. _____ A stem or leaf cutting must be kept moist.
10. _____ All kind of plants can be grafted together.

KEEPING UP WITH SCIENCE



A 30-INCH ORPPLE TREE?

Sometime in the future you may be eating apples from trees only 30 inches in height. You might eat something called a pomato, or possibly a topato, or even an orpple. And you might be using gasoline from the desert gopher plant. Biological engineers are now making new kinds of plants. These plants will produce new sources of food, new medicines, and new fuels.

In 1960, F.C. Stewart of Cornell University created a complete carrot plant from a single carrot cell. He put the cell on a jellylike substance in a test tube. Then he fed the cell with plant food. He made the cell divide by giving it a certain chemical (a growth hormone) that causes cell division. And the group of cells produced roots. Then fed with another hormone, it produced a shoot and became a whole carrot plant.

This process of cell regeneration has been improved. Now a cell from one kind of plant can be made to join a cell from another kind of plant. To do this, the walls

of the cells are dissolved by a certain chemical (an enzyme). The material that determines what the developed plant will be like from one cell joins the material of the other cell.

Then another chemical is added to make the combined cell produce another cell wall. And another chemical makes this cell divide, forming a mass of cells. Still another chemical makes any one of these cells generate into a whole plant.

The new plant will have some of the characteristics of the two different kinds of cells.

Through this new process of combining cells of different kinds of plants extraordinary new fruits, vegetables, bug- and drought-resistant grains may be made. The Campbell Soup Company now operates a laboratory for combining cells of disease-resistant plants with cells of tomato plants. Another laboratory expects to produce certain medicines from large quantities of plant cells stored in huge vats.

WHAT IS A FLOWER?

7



gamete: a male or female sex cell

sperm: a male sex cell

egg: a female sex cell

pollen: a plant's male sex cells

fertilization: the link-up of a sperm nucleus with an egg nucleus

AIM | What is a flower?

7

In asexual reproduction, there is no link-up of special sex cells. But in sexual reproduction, there is a link-up of two sex cells, one male and one female.

Sex cells are called *gametes* [GAM eets]. A male gamete is called a *sperm*. A female gamete is called an *egg*.

The link-up of the nucleus of a sperm with the nucleus of an egg is called *fertilization* [fur ti li ZAY shun]. Fertilization is the first step in sexual reproduction.

Most plants and animals reproduce sexually.

Special organs are needed for sexual reproduction. The organ of sexual reproduction in many plants is the *flower*. A flower makes a plant's gametes. Male and female gametes join to produce seeds. Then the seeds grow into new plants.

Let us examine the parts of a flower. Check with Figure A as you read.

The most important parts of a flower are the *stamens* [STAY minz] and the *pistil*.

STAMENS The stamen is the male part of a flower. Most flowers have several stamens.

A single stamen has two parts: a thread-like *filament* [FIL a mint], and a knob-like *anther*. The anther is at the top of the filament.

An anther makes a powdery substance called *pollen*. Pollen is made of a great number of *pollen grains*. Pollen grains are the sperm cells of a plant.

PISTIL The pistil is the *female* part of a flower. It is located in the center of the flower—inside the circle of stamens. Some flowers have more than one pistil.

The lower part of a pistil bulges. This bulge is the *ovary* [OH vuh ree]. An ovary contains one or more *ovules* [OH vyoolz]. Each ovule has an egg cell. Fertilization of an egg by a pollen grain takes place in the ovule. A fertilized egg becomes a seed. What will a seed produce?

WHAT ARE THE PARTS OF A FLOWER?

Study Figure A, a diagram of a flower. Then fill in the blanks.

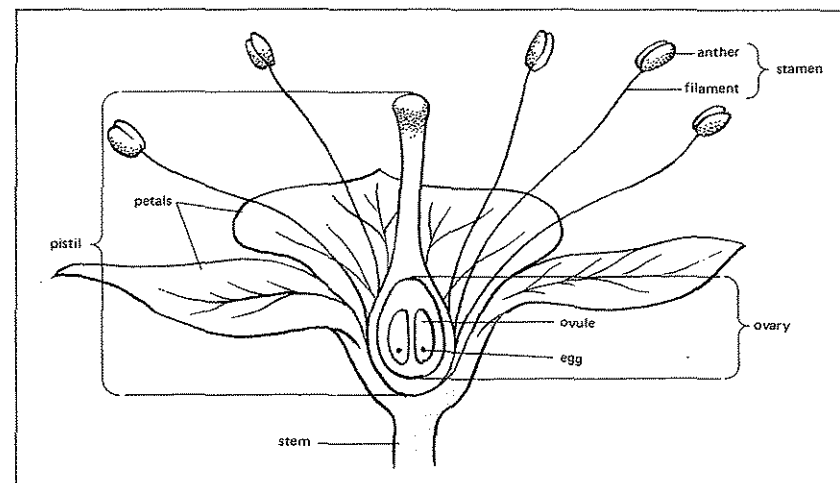


Figure A

1. Name the male part. _____
2. Name the female part. _____
3. Pollen is made by the _____
stamens, pistil
4. Eggs are made by the _____
stamens, pistil
5. How many stamens does this flower have? _____
6. a) Name the parts of a stamen. _____
b) Which part of a stamen makes the pollen? _____
7. What is the swollen part of a pistil called? _____
8. a) How many ovules does this ovary have? _____
b) How many eggs? _____
c) How many eggs are in each ovule? _____
9. How many seeds may this flower produce? _____
10. What do you call a flower's colorful leaf-like parts? _____

FEMALE OR MALE—OR BOTH?

- Some flowers have only stamens. They are male or staminate [STAM uh nit] flowers.
- Some flowers have only pistils. They are female or pistillate [PIST uh late] flowers.
- Most plants have both stamens and a pistil. They are called perfect flowers.

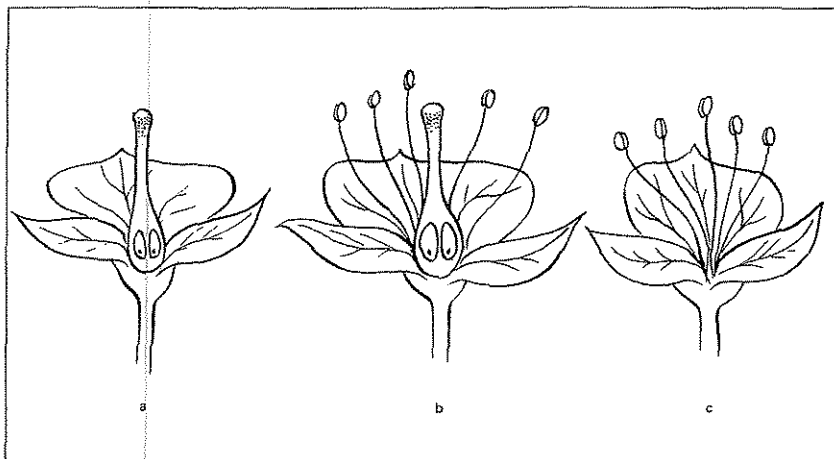


Figure B

Study the flowers in Figure B. Then answer the questions by letter.

1. Which is a staminate flower? _____
2. Which is a pistillate flower? _____
3. Which is a perfect flower? _____
4. Which makes only pollen? _____
5. Which makes only eggs? _____
6. Which makes pollen and eggs? _____
7. Which ones can produce seeds? _____
8. Look at the perfect flower. The stamens are _____ than the pistil.
higher, lower

COMPLETING SENTENCES

Complete the sentences with the choices below. One of these may be used twice.

stamens
ovary
sperm

anther
seed
pistil

egg
ovules
pollen

1. A female sex cell is called an _____.
2. Any male sex cell is called a _____.
3. Plant sperm are called _____.
4. The male part of a plant is made up of several _____.
5. The part of a stamen that makes pollen is the _____.
6. The entire female plant part is the _____.
7. The swollen part of a pistil is the _____.
8. An ovary has special parts called _____.
9. An ovule contains a single _____.
10. A fertilized plant egg cell becomes a _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-----------------------------|--|
| 1. _____ egg, sperm, pollen | a) male plant sex cells |
| 2. _____ egg | b) the union of a male and female gamete |
| 3. _____ pollen | c) kinds of gametes |
| 4. _____ fertilization | d) female plant part where fertilization takes place |
| 5. _____ ovary | e) female plant sex cell |

NAMING FLOWER PARTS

Name the parts of the flower in Figure C. Write the correct names on the blank lines. (Try not to look back.)
Choose from the following:

pistil
anther
petals

stem
ovule
filament

ovary
stamen
egg

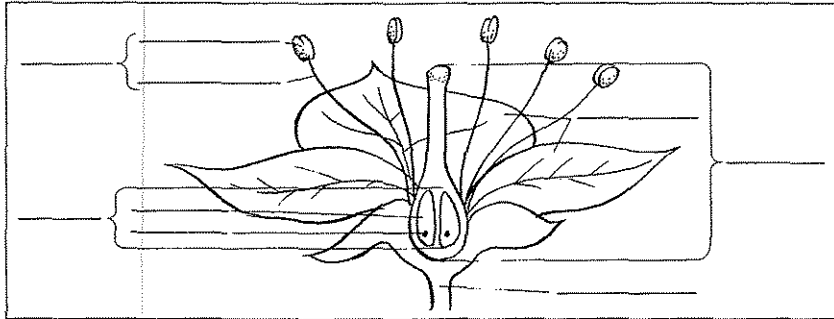


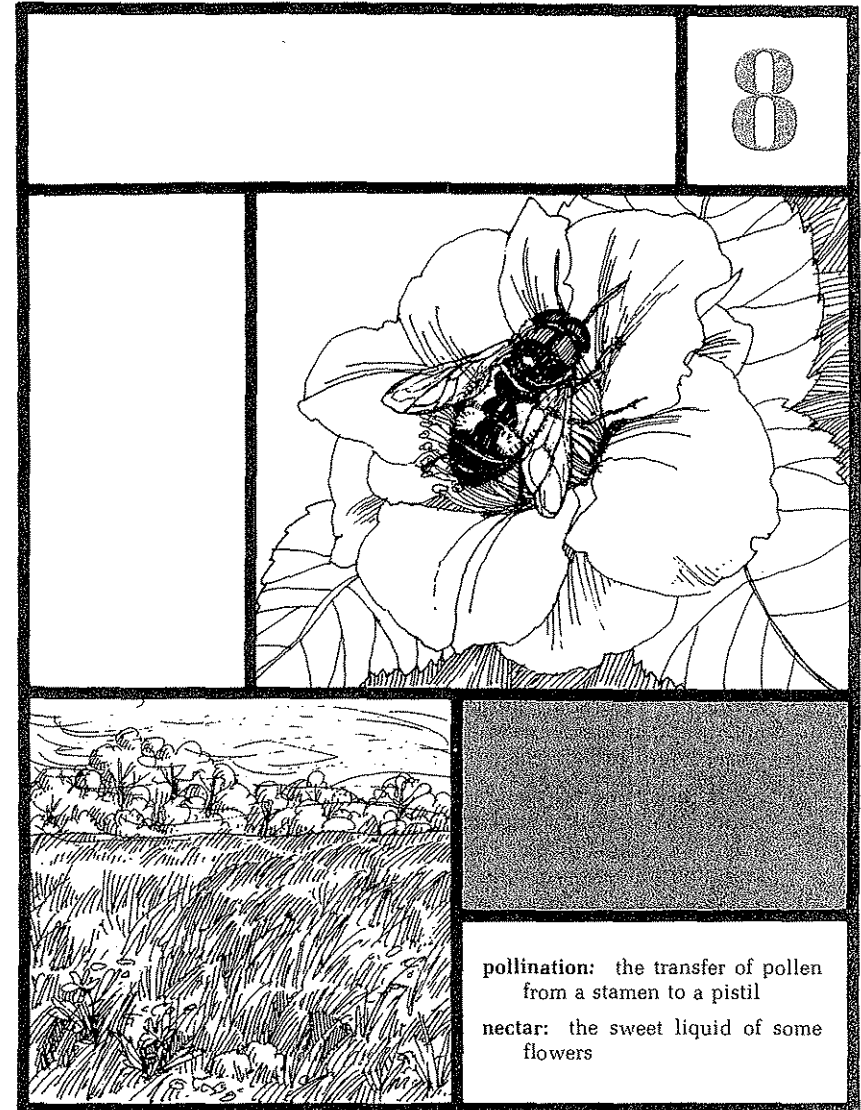
Figure C

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ A flower is an organ of asexual reproduction.
2. _____ All plants reproduce sexually.
3. _____ There are male plants and female plants.
4. _____ Some plants are both male and female.
5. _____ The most important parts of a flower are the stamens and the pistil.
6. _____ Stamens are female parts.
7. _____ Stamens make egg cells.
8. _____ An ovary has at least one ovule.
9. _____ One ovule has many eggs.
10. _____ A fertilized egg becomes a seed.

HOW DOES POLLEN REACH A PISTIL?

8



AIM | How does pollen reach a 8 | pistil?

Before a pollen grain can fertilize an egg, it must move from its stamen to a pistil. The transfer of pollen from a stamen to a pistil is called *pollination* [poll ih NAY shun].

There are two kinds of pollination—*self-pollination* and *cross-pollination*.

SELF-POLLINATION happens in perfect flowers. (A perfect flower has both stamens and a pistil.) Self-pollination takes place when pollen from a stamen lands on the pistil of the same flower.

CROSS-POLLINATION is the transfer of pollen from a stamen of one flower to the pistil of another flower.

Imperfect flowers pollinate *only* by cross-pollination. A male flower cannot pollinate itself. It has no pistil. A female plant makes no pollen. It must get pollen from some other plant.

Perfect flowers also cross-pollinate. A perfect flower may give or receive pollen from another flower.

What carries pollen from plant to plant? There are two main carriers—*wind* and *insects*.

WIND Pollen is like powder or dust. It is light in weight. Wind can carry pollen from one plant to the pistil of the same plant. Or, wind can carry pollen to the pistils of the same kind of plant far away. Wind helps pollinate corn plants.

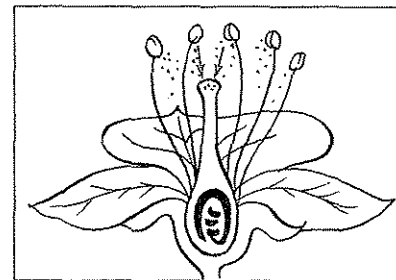
INSECTS Insects are attracted to flowers by their nice smell and bright colors. Insects also come to flowers to feed on a sweet liquid called *nectar* [NEK tur].

Insects search inside flower petals for nectar. As they search, some pollen sticks to their bodies. The insects then may visit other flowers. There, the pollen may rub off the insects and onto other pistils.

Some insects that carry pollen are flies, gnats, butterflies, moths, and bees. Bees are the most important. In fact, bees are often “hired” to pollinate fruit trees!

Hummingbirds and bats pollinate some flowers, too.

HOW POLLINATION TAKES PLACE



Gravity does the work in self-pollination. Pollen from stamens just drops onto the pistil of the same flower.

Figure A Self-pollination

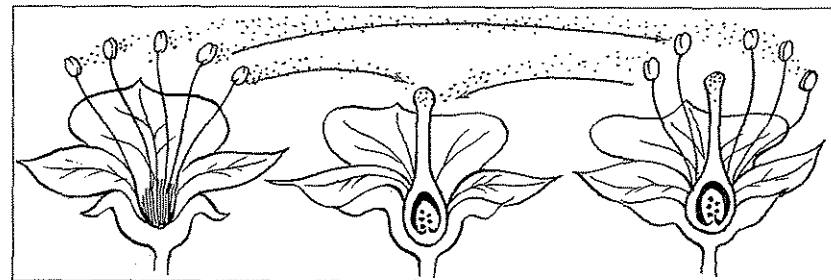


Figure B Cross-pollination

In cross-pollination, pollen from one flower is carried to the pistil of another flower.

CARRIERS OF POLLEN

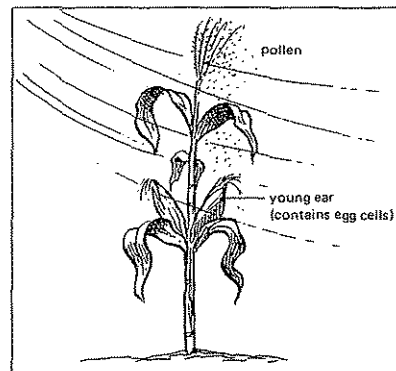


Figure C

Wind carries pollen from a corn plant to the pistil. The female part is actually cornsilk.

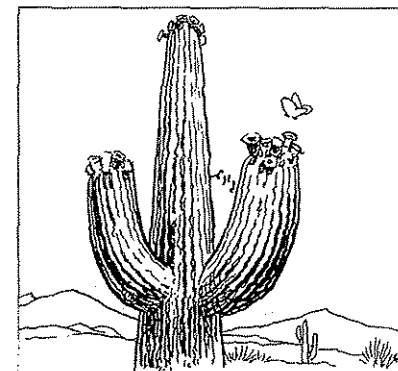


Figure D

Moths and butterflies carry pollen from plant to plant—even cactus plants.

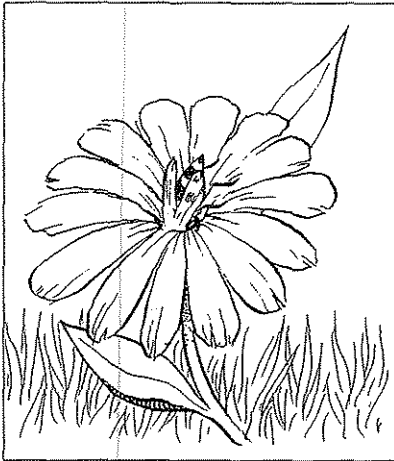


Figure E

Insects see colors that humans cannot. Some flowers have a colored "target" that is invisible to us.

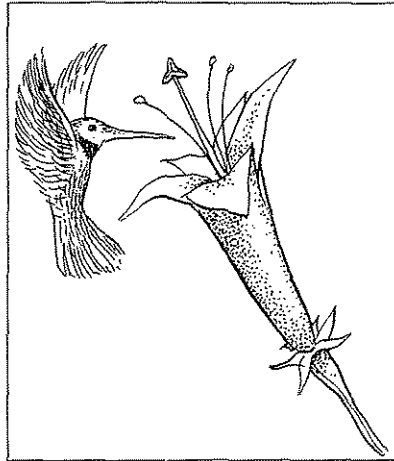


Figure F

Insects do not see red. It looks black to them. Most red flowers are pollinated by birds.

UNDERSTANDING POLLINATION

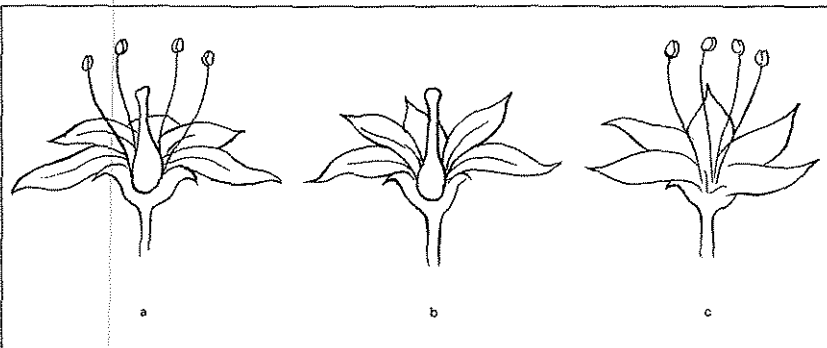


Figure G

Study the three flowers in Figure G. Then answer the questions below by letter.

1. Which flower makes pollen only? _____
2. Which flower makes eggs only? _____

3. Which flower makes pollen and eggs? _____
4. Which is the only self-pollinating flower? _____
5. Which flower can pollinate no flower? _____
6. Which flowers may flower c pollinate? _____
7. Which flowers may flower b pollinate? _____
8. Which is the perfect flower? _____
9. Which are the imperfect flowers? _____
10. In which plants can fertilization take place? _____

COMPLETING SENTENCES

Complete the sentences with the choices below. Three terms may be used twice.

self-pollination
wind
pistil
colors

pollen
smell
cross-pollination
egg

insects
stamens
pollination

1. Male sex cells in plants are called _____.
2. The male part of a plant is made up of _____.
3. The female part of a plant is called the _____.
4. In plants, fertilization takes place when a _____ nucleus links up with an _____ nucleus.
5. The transfer of pollen from any stamen to any pistil is called _____.
6. The two kinds of pollination are _____ and _____.
7. The pollination of a pistil by pollen from the same flower is called _____.
8. The pollination of a pistil by pollen from a *different* flower is called _____.
9. The main carriers of pollen are _____ and _____.
10. Insects, hummingbirds, and bats are attracted to flowers by their nice _____ and bright _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

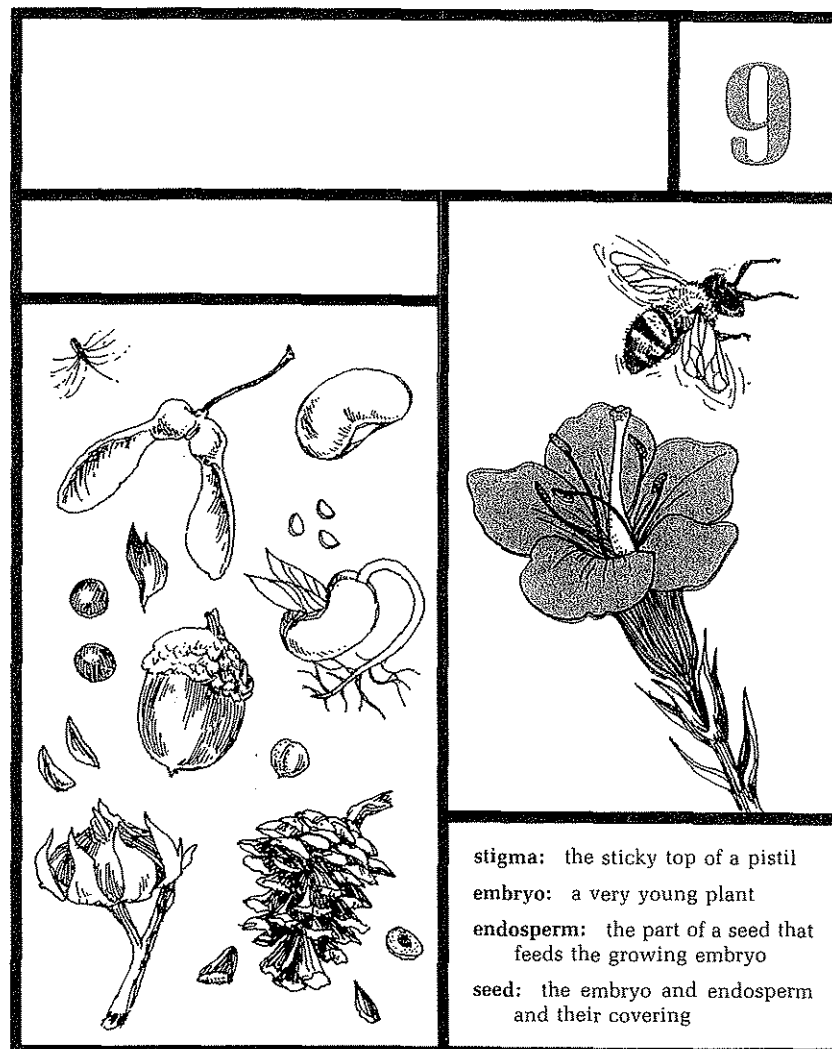
- | | | |
|----------|-------------------|--|
| 1. _____ | fertilization | a) plant's male and female sex cells |
| 2. _____ | pollen and egg | b) have only pistils or stamens |
| 3. _____ | perfect flowers | c) important pollen carriers |
| 4. _____ | imperfect flowers | d) the joining of a male and female sex cell |
| 5. _____ | bees | e) have both stamens and pistils |

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

- | | |
|----------------|-------|
| 1. TOPLONNILAI | _____ |
| 2. SROCS | _____ |
| 3. DIWN | _____ |
| 4. NISSETC | _____ |
| 5. LISTIP | _____ |

HOW DOES A POLLEN GRAIN FERTILIZE AN EGG?

9



stigma: the sticky top of a pistil
 embryo: a very young plant
 endosperm: the part of a seed that feeds the growing embryo
 seed: the embryo and endosperm and their covering

AIM | How does a pollen grain 9 | fertilize an egg?

A pollen grain has just landed on the pistil of a flower. How will it get into the ovary to fertilize an egg? A pollen grain cannot move by itself. So it actually grows down into the ovary! Figure A on the facing page shows how the pollen grain reaches the ovary. Check with Figure A as you read.

The top of a pistil has a sticky surface called a stigma. A pollen grain sticks to the stigma when it lands. Then the nucleus of the pollen grain divides into three parts. One part of the pollen grain grows down into the pistil. It makes way for the other two parts—two sperm nuclei.

The two sperm nuclei reach the ovary, where they fertilize the ovule. One sperm nucleus fertilizes the egg cell. This fertilized egg cell will become the baby plant. The baby plant is called the embryo [EM bree oh]. The embryo may grow into a new plant some day.

The other sperm nucleus joins with the rest of the ovule. This combined cell from the sperm nucleus and the rest of the ovule will become the food for the embryo. The stored food for the embryo is called the endosperm [EN duh sperm].

The endosperm and the embryo are surrounded by a tough covering. The embryo, the endosperm, and the covering make up a seed.

A seed may not grow right away. It can remain dormant. Something that is dormant is resting. A seed can stay dormant for a long time. When the conditions are right, the seed will stop being dormant. It will start to sprout. Then the embryo will need the stored food of the endosperm. As the young plant matures, it will begin to make its own food.

HOW A POLLEN GRAIN FERTILIZES AN EGG

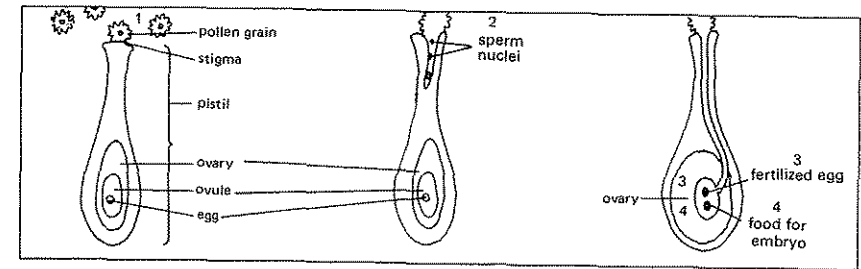


Figure A

Look at Figure A. Answer by number.

1. At what point does the pollen land on the stigma? _____
2. At what point is the pollen growing downward? _____
3. Where is the embryo? _____
4. Where is the endosperm? _____

WHAT IS A SEED?

The fertilized egg is a single cell. It divides many, many times. It becomes the embryo.

The endosperm cells also divide.

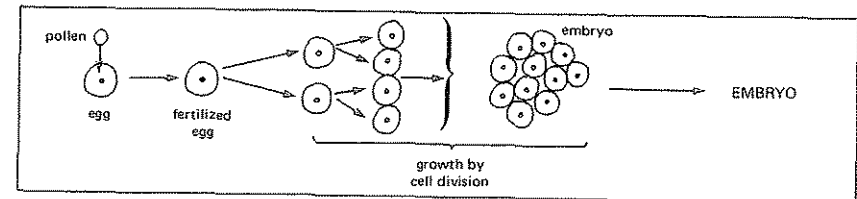


Figure B

The embryo and endosperm are surrounded by a covering.

The embryo, endosperm, and covering make a seed.

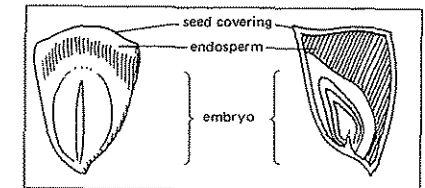


Figure C The parts of a seed

A mature seed will stay dormant until it is planted.

With proper moisture, soil, oxygen, and temperature, the seed will sprout.

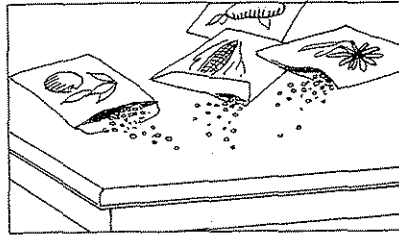


Figure D

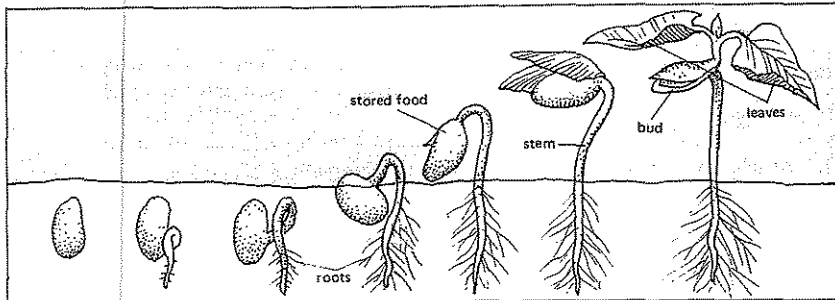


Figure E

The growing embryo feeds on endosperm until it grows green leaves. Then the plant makes its own food.

No matter how you face a seed when you plant it, its stem and leaves grow up and its roots down.

WHAT DOES THE PICTURE SHOW?

Can you identify the parts of a seed?

Look at Figure F. Write the correct letters in the spaces below.

1. _____ endosperm
2. _____ seed covering
3. _____ embryo

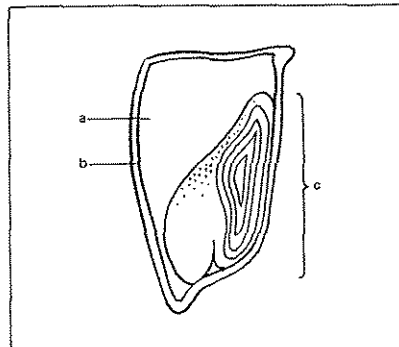


Figure F

COMPLETING SENTENCES

Complete the sentences with the choices below.

dormant
fertilization
pollen grain
ovary

food
embryo
seed covering

stigma
endosperm
seed

1. In plants, the male gamete is the _____.
2. The top of the pistil, the _____, has a sticky surface.
3. The pollen grain grows downward into the _____.
4. When the sperm and egg meet _____ takes place.
5. The fertilized egg is an _____.
6. The stored food is called the _____.
7. The embryo and stored food are covered by a _____.
8. The embryo, endosperm, and seed covering make up the _____.
9. If a seed does not sprout right away it stays _____.
10. The embryo uses the endosperm until it can make its own _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-----------------------|--------------------------|
| 1. _____ egg | a) young plant |
| 2. _____ pollen grain | b) male gamete |
| 3. _____ embryo | c) food for plant embryo |
| 4. _____ endosperm | d) contains ovules |
| 5. _____ ovary | e) female gamete |

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Pollen grains are male gametes.
2. _____ Fertilization starts when pollen lands on a stigma.
3. _____ A stigma is the top part of a stamen.
4. _____ A stigma is slippery.
5. _____ An egg is fertilized in an ovule.
6. _____ A fertilized plant egg becomes a seed.
7. _____ An embryo plant is a full-sized plant.
8. _____ The endosperm grows roots and leaves.

SPELL THE MISSING WORD Fill in the missing letters to spell the terms that fit the definitions.
When you have answered correctly, you will spell another term in the box.

1. t g a
 2. g
 3. m r o
 4. o m n
1. top part of a pistil
 2. female gamete
 3. baby plant
 4. resting

WHAT IS A FRUIT?

10



fruit: a ripened plant ovary and its seed (or seeds)
germinate: to sprout

AIM | What is a fruit?

10

Is a tomato a vegetable or a fruit? Most people would call it a vegetable. But a tomato is actually a fruit. So is a pepper. So is a cucumber. Does this surprise you?

What is a fruit? Let's start with a definition. A fruit is a swollen ovary with one or more ripe seeds.

You have learned that pollen grows into a pistil to fertilize the ovules in the ovary. This is how seeds are formed.

But something important happens as the seed or seeds develop. The ovary swells. It swells greatly. In fact the ovary may swell to hundreds or even thousands of times its original size.

A fruit has several important jobs:

- It protects its seed (or seeds) from insects, disease, and bad weather.
- It provides food for the developing embryo.
- It helps carry the seeds to places where they may grow.

Because some fruits contain a lot of food, people and animals eat them. There are other fruits that are not good to eat. Some are even poisonous.

THE MAKING OF A FRUIT

A plum tree has flowers in the spring. Later on it develops fruit.

Figures A through D show how a fruit develops. Answer the questions after you read each explanation.

Every plum flower has one ovule. Inside the ovule is one egg.

A single pollen nucleus fertilizes the egg nucleus.

1. Could this flower be self-pollinated? _____
2. In which part of the flower is the ovule found? _____

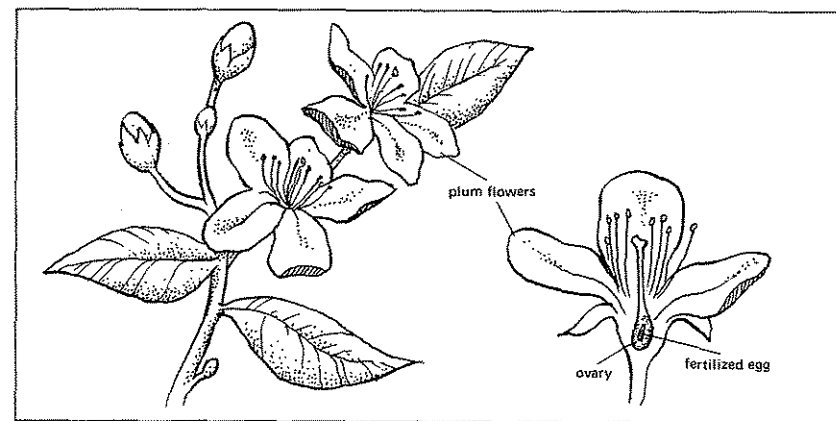


Figure A



Figure B

Inside the ovary the fertilized egg divides over and over again. An embryo plant along with endosperm is forming.

3. What do we call an embryo plant and its endosperm? _____
4. What is happening to the ovary as the seed is developing? _____
5. What happened to the petals soon after fertilization? _____



Figure C

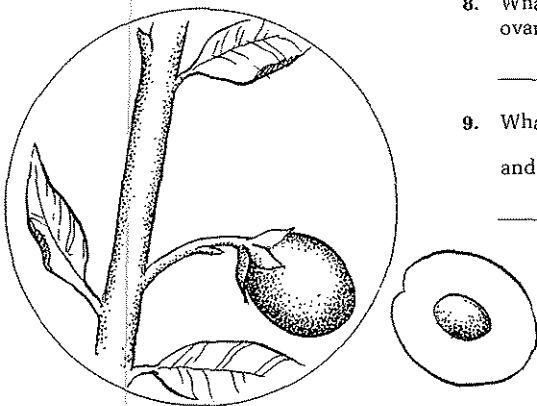


Figure D

To you, a fruit is ripe when it is good to eat. To a scientist, a fruit is ripe when its seeds can sprout or germinate ([J]ERM uh nate).

HOW MANY SEEDS DOES A FRUIT HAVE?

The number of seeds depends upon

- how many ovules (eggs) the ovary has,
- how many eggs are fertilized, and
- how many fertilized eggs grow well.

The seed continues to develop. The ovary continues to swell. (Figure C)

6. The stamens and the pistil are still on the plant. Can you find them? Draw an arrow to show where they are. Label the arrow.
7. What do you think will happen to the stamens and pistil? _____

The ovary swells even more. The seeds become ripe.

8. What do we call a swollen plant ovary and its seed (or seeds)? _____
9. What has happened to the stamens and pistil? _____

IMPORTANT

NOT ALL EGGS ARE FERTILIZED.

NOT ALL FERTILIZED EGGS BECOME SEEDS.

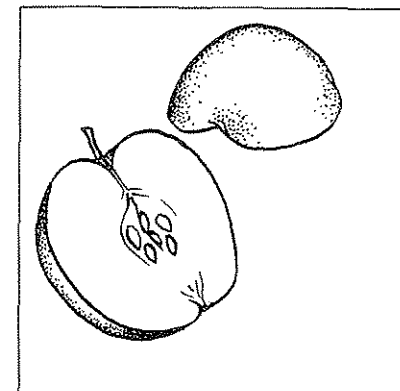
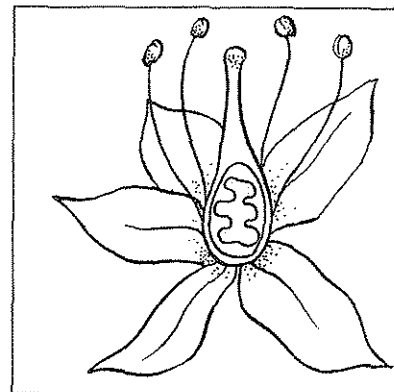


Figure E A blossom showing its ovary with six ovules. The ovules produced a fruit with six seeds.

For example:

An ovary with six ovules may become a fruit with six seeds. It may have fewer than five seeds — but no more.

Answer these questions.

1. Look back to Figure D. How many seeds does a plum have? _____
2. Look back to Figure A. How many ovules does the ovary of a plum flower have? _____

What Do You Think?

3. Which has more ovules, a plum ovary or a watermelon ovary?

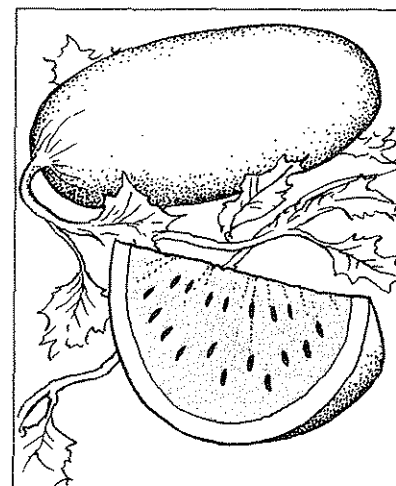


Figure F

TYPES OF FRUIT

There are four types of fruit. Two of these types are the **fleshy** fruits and the **dry** fruits.

- The ovaries of fleshy fruits fill with water and food material. They are "juicy."
- The ovaries of dry fruits do not fill with water. They are not juicy. Some are very hard.

Several fruits are shown in Figure G. Some are fleshy. Some are dry. Some have many seeds. Some have only one. Study the fruits. Then fill in the chart.

Choose the names of the fruits from the following:

apple
pear
peach

orange
pea
peanut

walnut
acorn

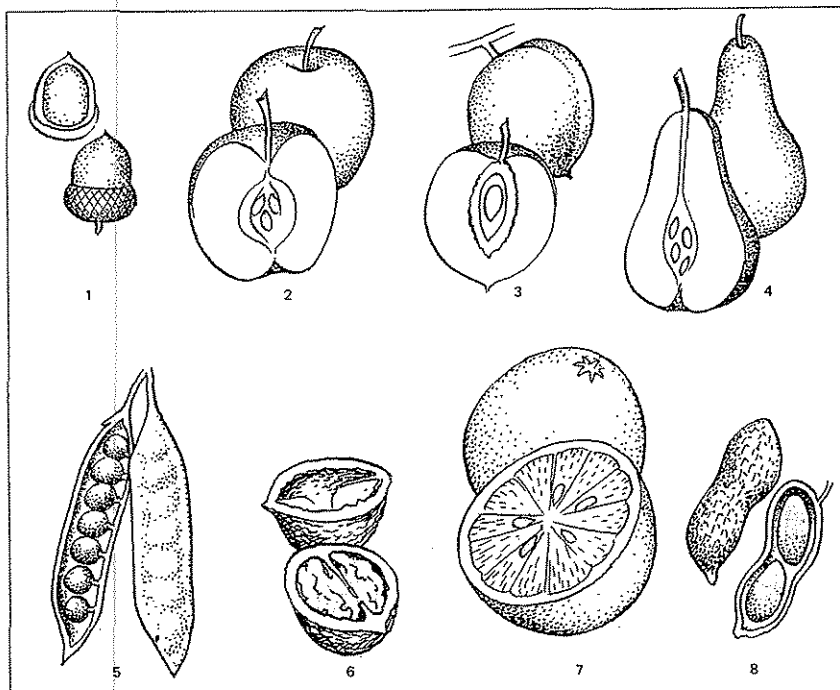


Figure G

	Name of Fruit	Fleshy or Dry?	How Many Seeds?
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

COMPLETING SENTENCES Complete the sentences with the choices below.

fleshy
pistil
germinate
peach

acorn
swell
egg
pollen grain

dry
ovary
fruit

- The entire female part of a flower is called the _____.
- The part of the pistil where ovules are found is the _____.
- One ovule produces one _____.
- An egg nucleus is fertilized by a single _____ nucleus.
- When an egg is fertilized, its ovary begins to _____.
- A swollen plant ovary along with its ripe seeds is called a _____.
- A fruit is ripe when its seeds can _____.
- Two types of fruit are the _____ fruits and the _____ fruits.
- An example of a dry fruit is an _____.
- An example of a fleshy fruit is a _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--|------------------------------|
| 1. _____ fruit | a) jobs of a fruit |
| 2. _____ protects, nourishes, and helps spread its seeds | b) types of fruits |
| 3. _____ dry and fleshy | c) male gamete |
| 4. _____ egg | d) female gamete |
| 5. _____ sperm or pollen | e) nature's "seed container" |

REACHING OUT

You can now buy some fruits that didn't exist before. They are "blends" of two different, but related, fruits.

For example, a tangelo is part tangerine, part grapefruit.

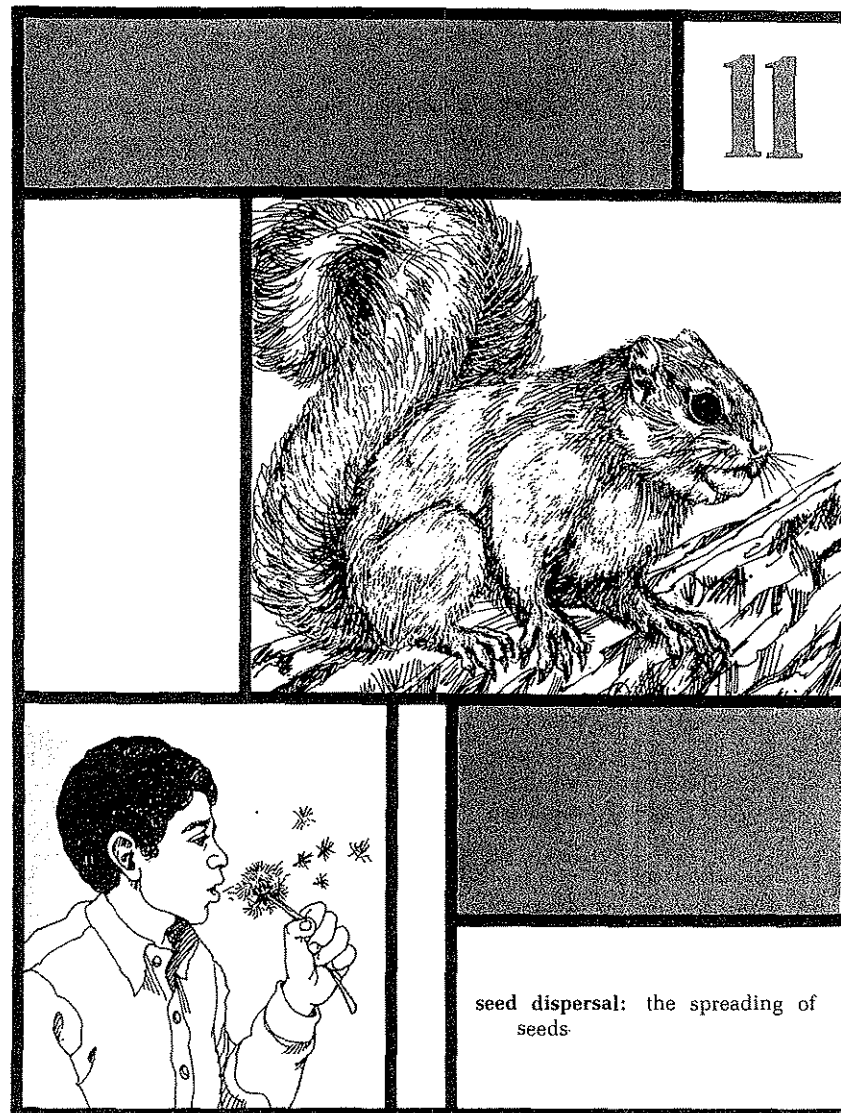
People help nature make this fruit. How is it done? _____



Figure H

HOW ARE SEEDS CARRIED FROM PLACE TO PLACE?

11



AIM | How are seeds carried from 11 place to place?

Did you ever hear anyone say, "The apple doesn't fall far from the tree"? Some fruits containing seeds drop close to the parent plant. But other kinds of seeds travel far away.

Can you imagine what would happen if all seeds were to fall near their parent plants? Too many plants would start to grow in one place. Soon there would not be enough soil, water, oxygen, and sunlight for all of them. Only a few would live.

Seed-spreading is needed for plants to survive. Seed-spreading is called *seed dispersal* [di SPUR sil]. Seeds are dispersed in several ways. These are the most important:

WIND Some tiny lightweight seeds are carried very far by the wind. Some heavier seeds have special parts that help them fly through the air. For example, maple seeds have "wings." Dandelion seeds have parachute-like tufts.

ANIMALS Some seeds have sticky parts. For example, the cocklebur has hooks. They stick to the fur of passing animals. Then they fall off somewhere else.

Animals disperse seeds in other ways. The animals eat many kinds of fruits—seeds and all. Many kinds of seeds are not changed by digestion. They remain "healthy" and can germinate. During excretion the animals pass these seeds from their bodies—usually far from the place where they were eaten.

Some animals, like squirrels, carry off and bury nuts for the winter. Later on, some of the nuts germinate.

EXPLOSIVE PARTS The ovaries of some fruits—like the poppy and the pea—"explode" when they mature. The seeds shoot out and land at a distance from the plant.

WATER Some fruits that grow near water can float. When the fruits fall in the water, currents carry them far away.

Coconut and lotus seeds are dispersed by water.

UNDERSTANDING SEED DISPERSAL

Look at Figures A through G. Answer the questions.



Figure A

WIND



Figure B

ANIMALS

1. Maple, milkweed, and dandelion seeds have "helpers" to fly about. Why don't tiny seeds need "helpers"? _____

2. This bird is eating berries—seeds and all. What will happen to the seeds? _____

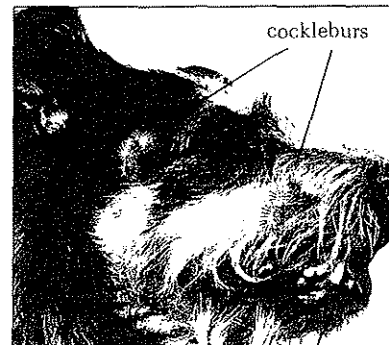


Figure C

ANIMALS

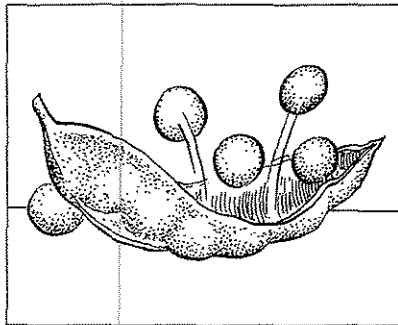


Figure D

ANIMALS

3. In time, what will happen to the cocklebur seeds sticking to this dog? _____

4. What will happen to some of the acorns this squirrel is holding? _____



EXPLOSIVE PARTS

When a pea pod dries, it twists. The pod breaks open suddenly. Out shoot the peas.

Figure E

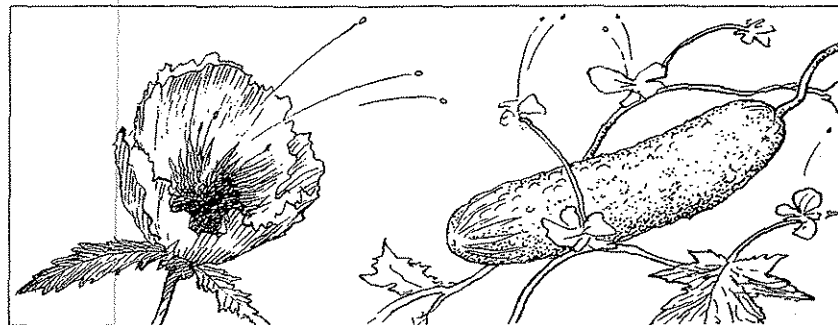


Figure F Poppy

Squirting cucumber

These fruits shoot their seeds into the air, too.

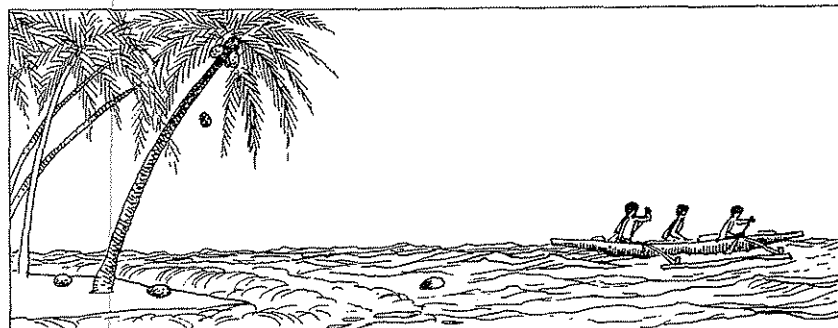


Figure G

WATER

5. How do you know that a coconut is lighter than water? _____

COMPLETING SENTENCES Complete the sentences with the choices below.

seed dispersal
"explodes"
wind
germinate
digestion

oxygen
soil
bury
dandelion
water currents

cocklebur
sunlight
water
maple

- Too many plants cannot grow in one small place because they cannot get enough _____, _____, _____, and _____.
- The spreading of seeds is called _____.
- Many kinds of seeds are carried through the air by the _____.
- Two plants with seeds that are carried by wind are _____ and _____.
- A _____ has hooks that stick to animals.
- Many kinds of seeds are not harmed by _____.
- A pea pod _____ its seeds out when it matures.
- Squirrels _____ nuts. Some of them _____.
- Coconut seeds are dispersed great distances by _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--------------------------|--------------------------------------|
| 1. _____ seed dispersal | a) dispersed by water |
| 2. _____ coconut seeds | b) does not harm many kinds of seeds |
| 3. _____ dandelion seeds | c) dispersed by wind |
| 4. _____ squirrels | d) any seed-spreading |
| 5. _____ digestion | e) help disperse acorns |

REACHING OUT

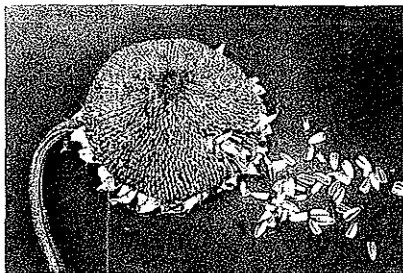


Figure H

A species of flower produces many more seeds than is needed for the species to survive. Why are so many seeds produced? _____

SPELL THE MISSING WORD

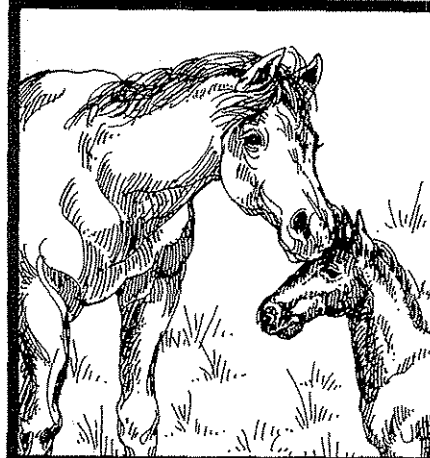
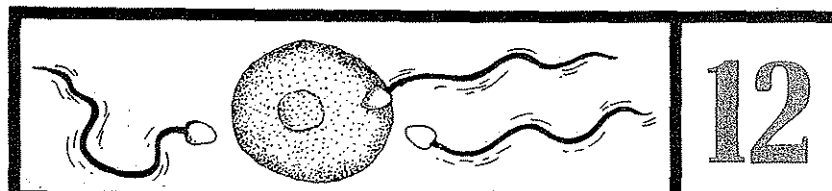
Fill in the missing letters to spell the terms that fit the definitions.

When you have answered correctly, you will spell another term in the box.

- | | | | | | | | |
|----|---|--|---|---|---|---|-----|
| 1. | | | | | a | e | |
| 2. | x | | l | s | v | | |
| 3. | | | | a | i | a | s |
| 4. | | | | | i | p | r a |

1. disperses coconut and lotus seeds
2. _____ parts
3. birds and squirrels
4. seed-spreading

HOW DO ANIMALS REPRODUCE SEXUALLY?



testes: the organs that produce sperm

zygote: a fertilized egg

external fertilization: fertilization that takes place outside an organism's body

internal fertilization: fertilization that takes place inside an organism's body

AIM | How do animals reproduce sexually?

12 | sexually?

You have learned how plants reproduce sexually. Most animals reproduce sexually, too. For both plants and animals to reproduce sexually, two parents are needed. The male provides the sperm; the female provides the egg.

In animals, special organs of the body are needed for reproduction.

- Male organs, called *testes* [TES teez], produce sperm gametes.
- Female organs, called *ovaries*, produce egg gametes.

Reproduction starts when a sperm nucleus joins or fertilizes an egg nucleus. The fertilized egg is called a *zygote* [ZY goat]. It is the beginning of a new life.

A zygote is a single cell. Soon after it forms, it divides. It becomes two cells. Each of these cells then divides. They become four cells. Then these cells divide. Cell division continues over and over again. A young organism or *embryo* forms. As the cells divide, they form tissues. The tissues form organs. . . . The embryo grows in size. As it grows, it takes on the form of its parents. When the embryo reaches full size, it is "born." The offspring is now an organism on its own. It must carry out all the life functions by itself.

In some animals, fertilization takes place *outside* the body. In other animals, fertilization takes place *inside* the female's body.

Fertilization that takes place outside the body is called *external fertilization*. Amphibians and most fish reproduce by external fertilization.

Fertilization that takes place inside the body is called *internal fertilization*. Birds, reptiles, and mammals reproduce by internal fertilization.

EGG AND SPERM CELLS ARE VERY DIFFERENT

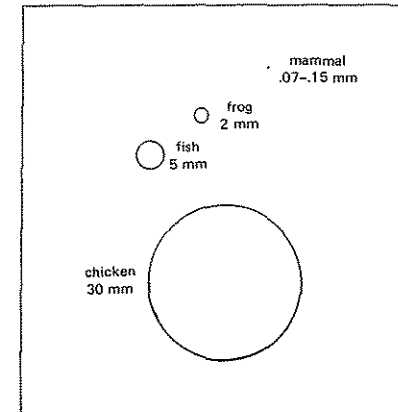


Figure A Egg cells (actual size)

An egg is round and large. Most eggs can be seen with the eye alone.

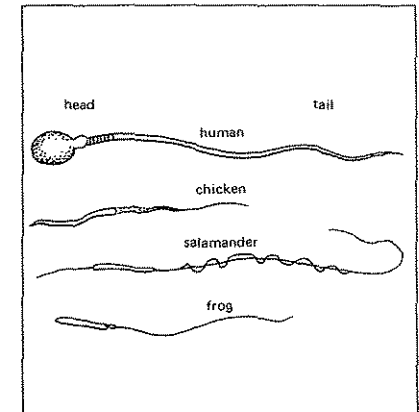


Figure B Sperm cells (greatly enlarged)

A sperm is very tiny. It is microscopic.

A sperm has a "head" and a "tail." The tail lashes back and forth. This moves the sperm forward.

A sperm is free-swimming. An egg is not.

FERTILIZATION

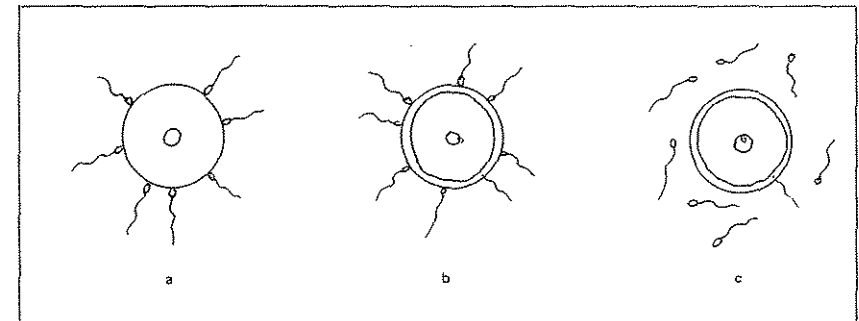


Figure C

Figure C shows the fertilization of a human egg.

Study Figure C. Then answer the questions.

1. Which is larger, a sperm or an egg? _____

2. Which is smaller, a sperm or an egg? _____
3. A sperm is _____ smaller than an egg.
slightly, much
4. Which is the male gamete? _____
5. Which is the female gamete? _____
6. Which one is free-moving? _____
7. How many sperm swim toward an egg? _____
only one, many
8. How many sperm enter the egg? _____
only one, many
9. How many sperm fertilize the egg? _____
only one, many
10. a) Which part of the sperm enters the egg? _____
b) Which part is left behind? _____
11. Complete this sentence: Fertilization takes place when a _____ links up with an _____.

HOW ANIMAL EMBRYOS GROW

The moment fertilization takes place, the plan for the way an animal will develop is set. For example, a fish zygote develops into a fish. A turtle zygote develops into a turtle. A human zygote develops into a human.

BUT, notice something very interesting. At the early stages of development, animals with backbones look very similar.

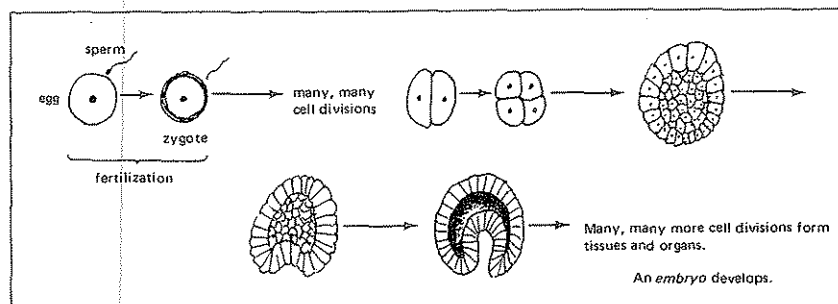


Figure D

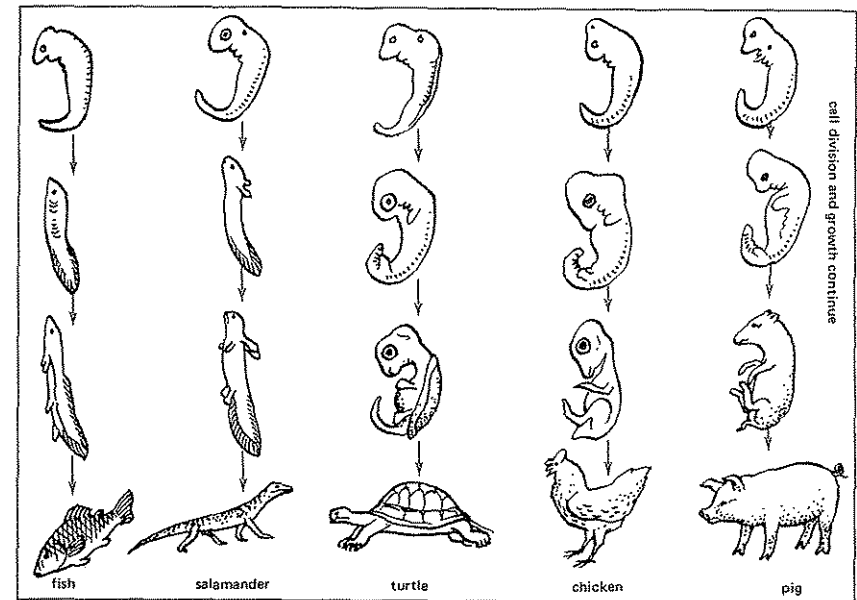


Figure E The development of five different kinds of animals. Notice how similar they are in their early stages of development.

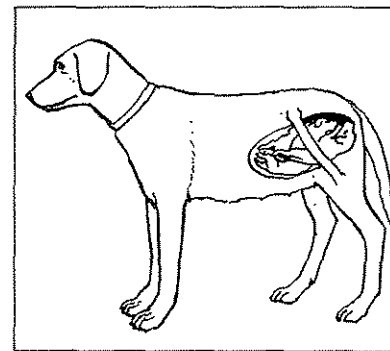


Figure F

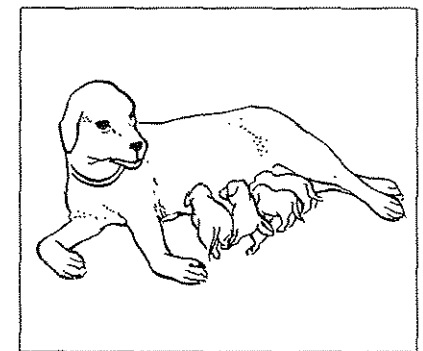


Figure G

Animals like dogs, cats, horses, and whales are *mammals*. Humans are mammals, too.

Mammal eggs are fertilized internally. The embryos develop internally too. When an embryo is fully developed, a baby is "born."

Female mammals produce milk to feed the newborn.

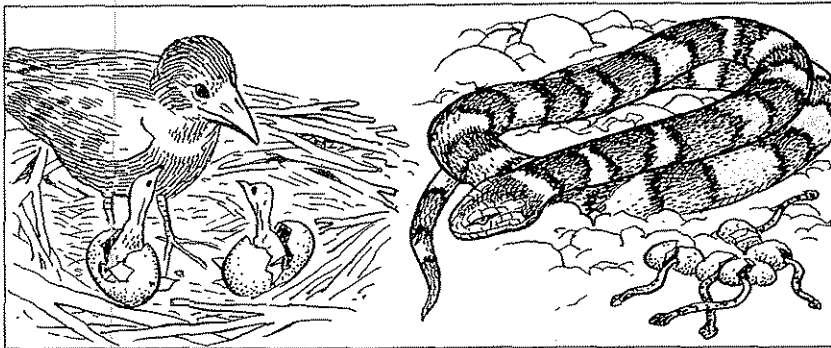


Figure H

Animals like birds and snakes are not mammals.

The female lays the fertilized eggs. The embryos then develop outside of the female's body. When the embryos are fully developed, they "hatch."

SOME INTERESTING FACTS ABOUT MAMMAL REPRODUCTION

The time between fertilization and birth is called the *gestation* [je STAY shun] time. Gestation time varies greatly with different animals.

Animal (mammal)	Gestation time (approximate)
hamster	16½ days
house mouse	21 days
rabbit	30 days
dog or cat	63 days
lion	108 days
chimpanzee	237 days
human	267 days
cow	281 days
horse	336 days
elephant	660 days

Usually . . .

- the smaller the animal, the _____ the gestation time.
longer, shorter
- the larger the animal, the _____ the gestation time.
longer, shorter
- Which animal on the chart has the longest gestation time? _____
- Which animal on the chart has the shortest gestation time? _____

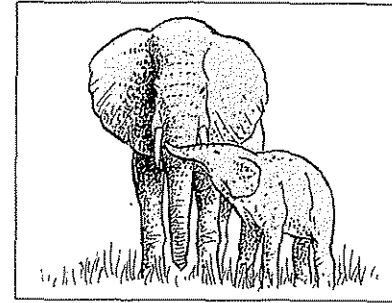


Figure I

At birth, an elephant is about 1 meter (3 feet) tall and weighs about 91 kilograms (200 lb).

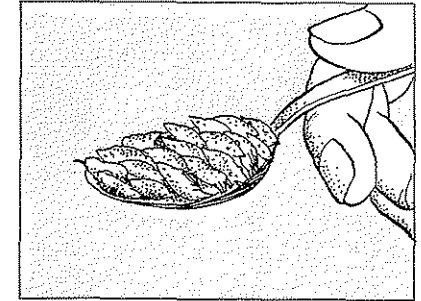


Figure J

Newborn opossums are so tiny that 15 to 18 of them can fit into just one teaspoon.

How many offspring do mammals usually produce at one time? It depends upon the animal. Some examples are shown in Figures K through P.



Figure K

Elephant and horse—1



Figure M

House cat—4 or 5



Figure L

Human—1



Figure N

Dog—1 to 12

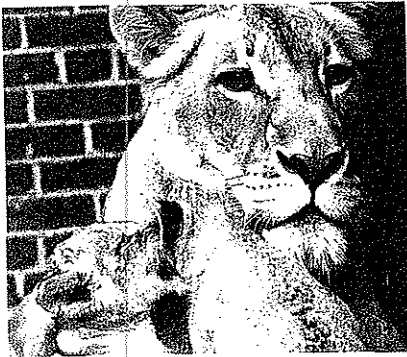


Figure O

Lion—3 to 5



Figure P

Mouse—4 to 7

5. What does the number of offspring tell us about the number of eggs fertilized?

6. a) How many eggs does a human female usually produce at one time?

b) How do you know?

TRUE OR FALSE Write T on the lines next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Only animals reproduce sexually.
2. _____ All animals reproduce sexually.
3. _____ Sexual reproduction needs two parents.
4. _____ Females produce egg gametes.
5. _____ Males produce sperm gametes.
6. _____ Egg gametes are free-moving.
7. _____ Egg gametes are larger than sperm.
8. _____ Many sperm cells fertilize one egg.
9. _____ A fertilized egg divides many, many times.
10. _____ An embryo is a full-grown organism.

COMPLETING SENTENCES

gamete
internal
ovaries
two

male
fertilization
sperm
testes

sexual
eggs
external
female

1. Most animals reproduce by _____ reproduction.
2. Sexual reproduction needs _____ parents. One parent is a _____; the other parent is a _____.
3. A male or female sex cell is called a _____.
4. Male gametes are called _____.
5. Female gametes are called _____.
6. Sperm cells are produced by organs called _____.
7. Eggs are produced by organs called _____.
8. The link-up of a sperm nucleus with an egg nucleus is called _____.
9. Fertilization that takes place outside the body is called _____ fertilization.
10. Fertilization that takes place within a female's body is called _____ fertilization.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|---------------------------------|-------------------|
| 1. _____ sperm | a) most fish |
| 2. _____ egg | b) male gamete |
| 3. _____ zygote | c) fertilized egg |
| 4. _____ internal fertilization | d) mammals |
| 5. _____ external fertilization | e) female gamete |

REACHING OUT

Look back to Figure C.

Only one sperm fertilizes an egg.

After fertilization takes place, something happens to the egg. This prevents other sperm from entering.

What happens? _____

WORD Unscramble each of the following to form a word or term that
SCRAMBLE you have read in this Aim.

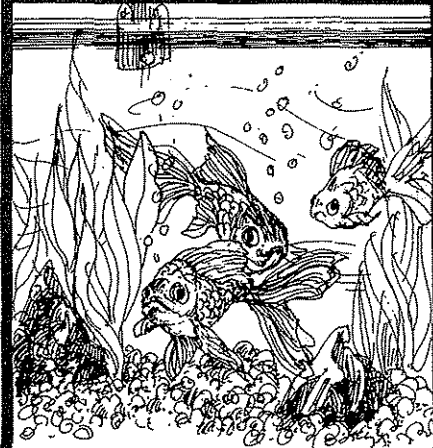
1. ERASIVO _____
2. GOZETY _____
3. ANNLITER _____
4. LAMMAM _____

HOW DO FISH REPRODUCE?



13





roe: fish eggs
yolk: the food material in an egg
milt: liquid containing sperm that is released by male fish
spawning: the depositing of fish eggs
fry: very young fish

AIM | How do fish reproduce?

13

Did you ever own a fish tank? Did you raise guppies? Did you see a female guppy giving birth?

Fertilization in guppies takes place internally—inside the female's body. The embryos develop internally, too. The young are born alive. The moment they are born, they are on their own. They swim off, search for food, and hide from danger.

Most fish do not develop this way. In most fish, fertilization and embryo growth are *external*. Eggs are fertilized and develop in water—outside the female's body.

This is what happens:

1. The female lays many thousands—even millions—of eggs called *roe*. Each egg has a large amount of food material called *yolk*.

The depositing of unfertilized fish eggs is called *spawning*.

2. The male swims over the eggs. He deposits a liquid called *milt*. Milt contains millions of sperm. The free-swimming sperm reach the eggs and fertilize them. Many *zygotes* are formed.

3. Each *zygote* divides many times. The *zygote* becomes an *embryo*. The embryo develops into a very young fish called a *fry*. When the fry has grown to proper size, it hatches out of the egg.

4. Part of the egg, called the *yolk sac*, stays attached to the baby fish. It feeds the fry. As the fry grows, the yolk sac shrinks. Soon, the sac is used up. The fry is now a fish. It is big enough to search for its own food.

THE LIFE OF A FISH STEP BY STEP

Look at Figures A through C. Answer the questions with each.

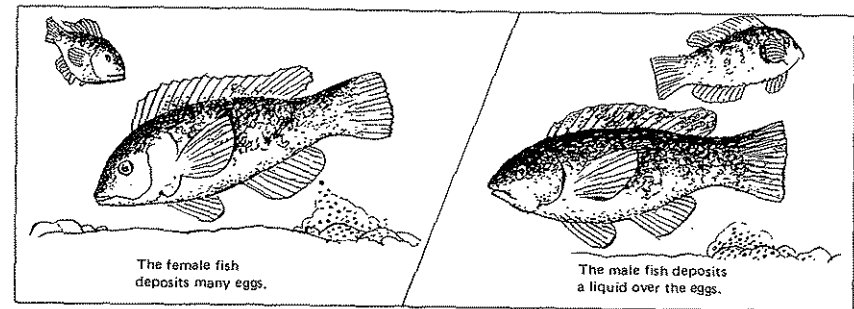


Figure A

1. What do we call the depositing of unfertilized fish eggs? _____
2. What name is given to the mass of fish eggs? _____
3. a) What is the liquid in Figure A called? _____
b) What does it contain? _____

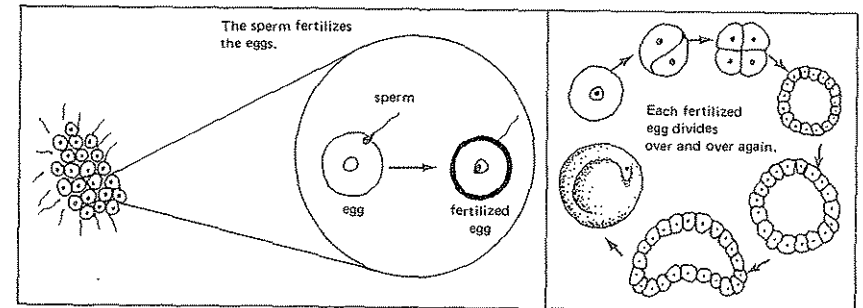


Figure B

4. How do the sperm reach the eggs? _____
5. How many sperm cells fertilize one egg? _____
6. What is a fertilized egg called? _____
7. What forms first from the many cell divisions? _____
8. What is a very young fish called? _____

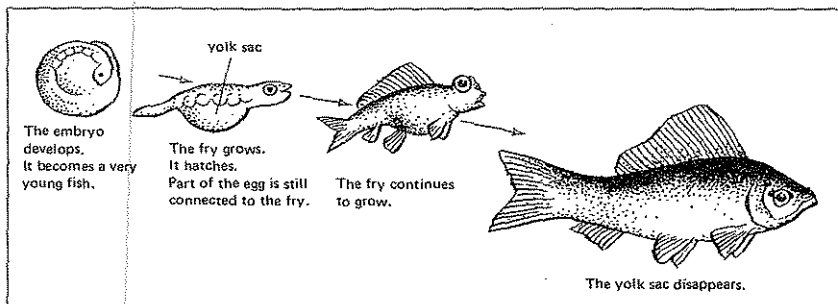


Figure C

9. a) What do we call the part of the egg that is connected to the fry?

 - b) What is its job? _____
10. What happens to the yolk sac as the fry grows? _____
11. a) Look at the end drawing of Figure C. What has happened to the fry? _____
 - b) How will the fish now get its food? _____

SOME UNUSUAL FISHES

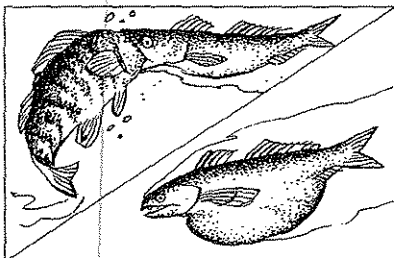


Figure D

The Black Swallower lives in the deep ocean. Its stomach and mouth can stretch greatly. The Swallower can gulp in a whole fish many times larger than its own size.

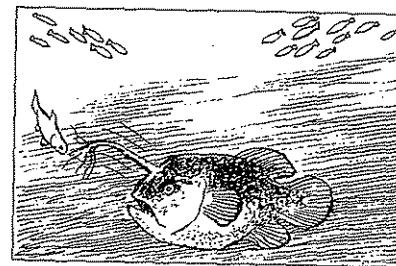


Figure E

The Angler Fish looks like a rock as it rests on the bottom of warm seas. It has a flower-like growth on its nose. Other fish come to eat the "flower." The Angler eats the fish instead!

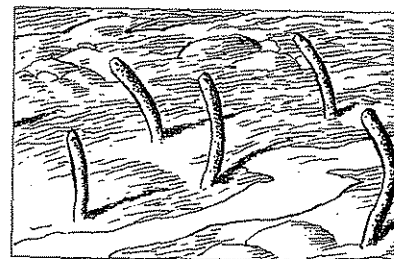


Figure F

The Garden Eel lives in colonies. Each eel makes a burrow a good distance away from its neighbor. It eats tiny organisms that drift by.

SOME UNUSUAL BREEDING HABITS

The female Convoy Fish carries her fertilized eggs in her mouth until they hatch. The hatched baby fish swim near the mother. When there is danger, the babies dash back into the mother's mouth.

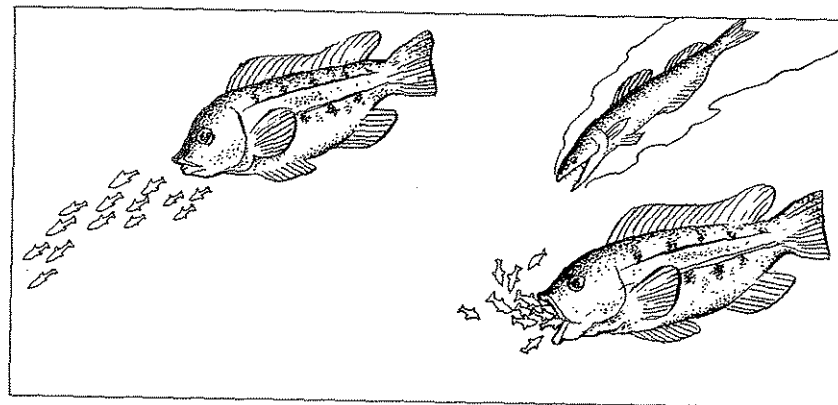


Figure G

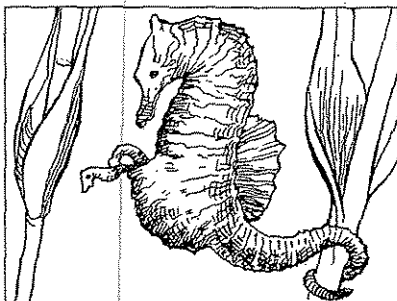


Figure H

The Sea Horse is not a horse at all. It just looks like a horse.

The male Sea Horse takes care of fertilized eggs. He carries them in a pouch on his belly until they hatch.

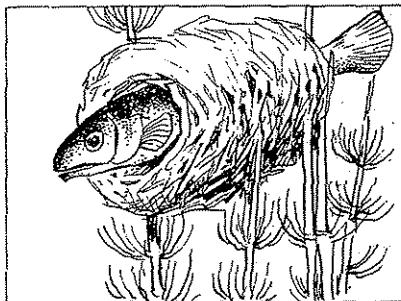


Figure I

Only birds build nests? Not so! The Brook Stickleback Fish builds a nest from plant strands. The female lays her eggs in the nest.

COMPLETING SENTENCES

Complete the sentences with the choices below.

outside
fry
roe
milt

yolk sac
externally
fish

spawning
sperm
feeds

1. In most fish, fertilization and embryo development take place _____.
2. In external fertilization, the egg is fertilized _____ of the females body.
3. A mass of fish eggs is called _____.
4. The depositing of unfertilized fish eggs is called _____.
5. The liquid deposited over the eggs by a male fish is called _____.
6. Milt contains millions of _____.
7. A very young fish is called a _____.
8. The part of the egg connected to a hatched fry is called the _____.
9. The yolk sac _____ the developing fry.
10. When a yolk sac is used up, the fry has become a _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|---------------------------------|---------------------------------|
| 1. _____ external fertilization | a) the depositing of fish eggs |
| 2. _____ roe | b) mass of fish eggs |
| 3. _____ spawning | c) method for most fishes |
| 4. _____ milt | d) developing fish |
| 5. _____ fry | e) liquid containing fish sperm |

TRUE OR FALSE

Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ All fish reproduce the same way.
2. _____ Most fish eggs are fertilized outside the female's body.
3. _____ Most fish embryos develop inside the female's body.
4. _____ Male fish spawn.
5. _____ Male fish produce roe.
6. _____ Roe are fish eggs.
7. _____ Milt contains millions of sperm.
8. _____ One sperm fertilizes one egg.
9. _____ A young fish is called a fry.
10. _____ A young fish is a fry until it uses up its yolk sac.

REACHING OUT

A fish is a vertebrate [VER ti brayt].

A vertebrate is an animal with a backbone.

1. a) Do you have a backbone? _____
- b) Are you a vertebrate? _____
- c) Name two other vertebrates. _____
- d) Can you name any animals that are not vertebrates? _____

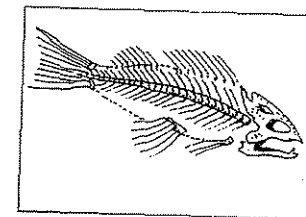


Figure J

2. Name some vertebrates that reproduce by internal fertilization only. _____

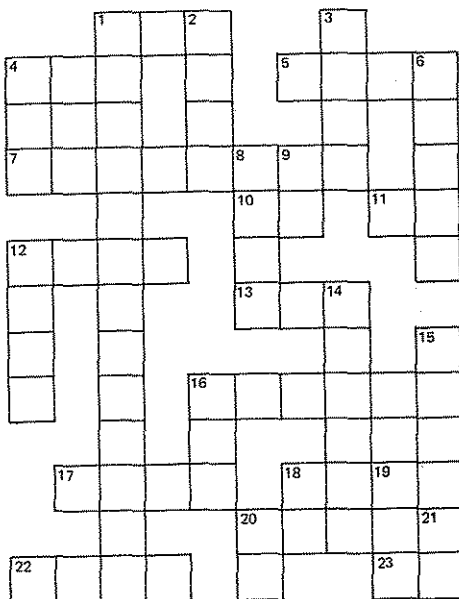
CROSSWORD Fill in the blank spaces by following the clues across and down. PUZZLE

ACROSS

1. Young fish
4. A part of your foot
5. Group of animals that live in water
7. The kind of fertilization found in humans
10. "RIGHT _____!"
11. Not down
12. The part of an egg that contains food
13. Female sex cell
16. A developing plant or animal
17. Mass of fish sperm
20. Male sex cell
22. Moving air
23. Abbreviation for southeast

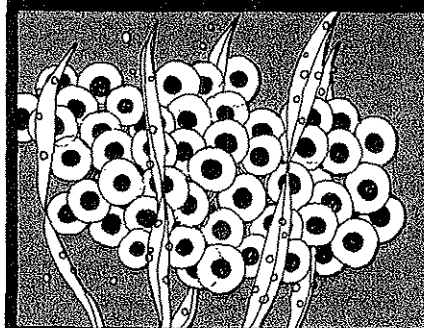
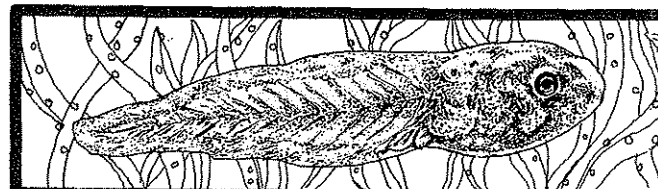
DOWN

1. The joining of a male and female gamete
2. 365 days
3. "_____ 'er up!"
4. Prefix meaning "three"
6. Not sad
8. Not even one
9. "_____ apple a day..."
12. This toy has its "ups and downs"
14. Boy's name
15. Fish eggs
16. Take in food
18. Same as 11 Across
19. Abbreviation for doctors
20. Abbreviation for street
21. Self



HOW DO FROGS REPRODUCE?

14



amphibian: an animal that spends its early life in water and its later life both on land and in water; a frog is an amphibian

gills: the breathing organs of tadpoles and fish

metamorphosis: a complete change in body form that happens to some organisms as they develop

AIM | How do frogs reproduce?

14

A frog is a special kind of vertebrate. It is called an amphibian [am FIB ee un]. A frog, like most amphibians, spends part of its life in water and part on land. Its early life is spent in water. Its adult life is spent mostly on land.

A young frog can breathe only in water. An adult frog can breathe on land as well as in water. On land an adult breathes by means of lungs. In water, it breathes through its skin.

Frogs reproduce in water by external reproduction. Let's see how it happens:

1. The female lays hundreds—even thousands—of eggs.
2. The male releases his sperm at the same time that the eggs are released.
3. The sperm cells fertilize the eggs. (The parents do not stay with the eggs. They return to land.)
4. The fertilized eggs cluster together and swell greatly. They become surrounded with a protective jelly-like material. Cell division and growth follow.
5. In about two weeks, the newborn hatch. A newborn frog is called a tadpole. But a tadpole isn't really a frog—not yet. It doesn't even look like a frog. It slowly changes to a frog.
 - A tadpole has a tail but no legs. It has gills. It can breathe only in water.
 - As the tadpole grows, it loses its tail and gills. It develops lungs and four legs. After 8 to 12 weeks, the tadpole has changed to a frog. It now leaves the water and becomes a land animal.

From tadpole to frog is a complete change in body form. A change in body form that certain animals go through as they grow is called metamorphosis [met uh MORE fuh sis].

THE LIFE STORY OF A FROG STEP BY STEP

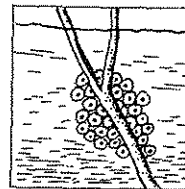


Figure A

A fertilized egg mass

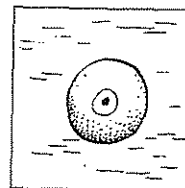


Figure B

A fertilized egg

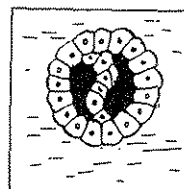


Figure C

Embryo

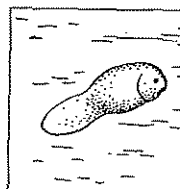


Figure D

Newly hatched offspring

A mass of fertilized frog eggs looks like jelly with white and black spots. The black spots are zygotes. The white spots are yolks.

1. What will the yolks be used for? _____

2. Frog fertilization is _____ internal, external

3. What is a fertilized egg called? _____

4. What fertilizes an egg? _____

5. The zygote becomes an embryo. For this to happen, the zygote _____ over and over again.

6. What do we call a young frog offspring? _____

7. A tadpole can live only _____ in water, on land

8. A tadpole breathes by means of _____ lungs, gills

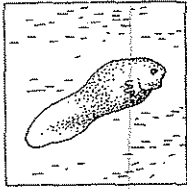


Figure E

Full-sized tadpole



Figure F

Hind legs form

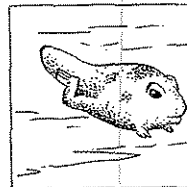


Figure G

Front leg "buds" start to appear



Figure H

Adult frog

9. The tadpole tail has grown. Of what use is the tail?

10. What is happening to the gills? _____

11. What is developing inside that will take the place of the gills? _____

12. What is happening to the hind legs? _____

13. What is happening to the tail? _____

14. Is any part of the tail left? _____

15. How many legs does the frog have? _____

16. Does the frog have gills any more? _____

17. a) What does the adult frog use for breathing on land? _____

- b) What does the adult frog use for breathing in water? _____

Frogs are important because they eat insects.

A frog has a very long sticky tongue. It is rolled up in its mouth, but it springs out suddenly to catch insects.

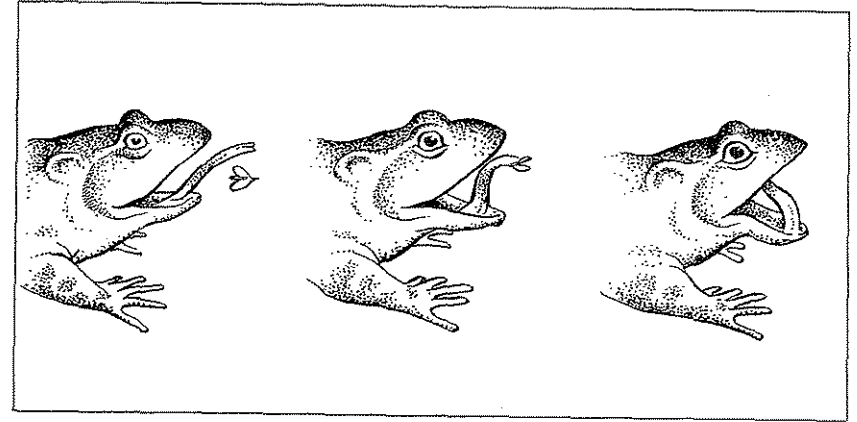


Figure I

How large is a frog? Frog size varies greatly.



Figure J

This young Western Tree Frog is less than 2½ cm (one inch) long.

Even when full grown, it will measure less than 5 cm (2 inches) long.

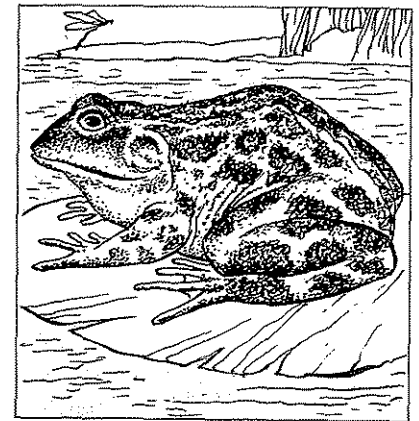


Figure K

An adult bullfrog is about 18-20 cm (7-8 inches) long.

COMPLETING SENTENCES

Complete the sentences with the choices below. One of these may be used twice.

external
lungs
does not
water

tail
legs
vertebrates
land

amphibian
tadpole
metamorphosis
gills

1. Animals with backbones are called _____.
2. A frog is a special kind of vertebrate called an _____.
3. An amphibian spends its early life in _____ and its adult life on _____.
4. Frogs reproduce in _____.
5. Frogs reproduce by _____ fertilization.
6. A young frog offspring is called a _____.
7. A tadpole _____ look like a frog.
8. A tadpole has a _____ and _____.
9. A tadpole does not have _____ or _____.
10. A change in body form that happens to some animals as they grow is called _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|------------------------|---------------------------------|
| 1. _____ frog | a) young frog offspring |
| 2. _____ tadpole | b) for breathing on land |
| 3. _____ gills | c) complete change in body form |
| 4. _____ lungs | d) amphibian vertebrate |
| 5. _____ metamorphosis | e) for breathing in water |

TRUE OR FALSE

Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ Frogs have backbones.
2. _____ Frog eggs are fertilized inside the female's body.
3. _____ Frogs reproduce on land.
4. _____ A female frog protects her fertilized eggs.
5. _____ A young frog offspring is called a fry.
6. _____ Tadpoles breathe only in water.
7. _____ A tadpole has gills and a tail.
8. _____ A frog has gills and a tail.
9. _____ A frog can breathe on land and in water.
10. _____ A frog can breathe through its skin.

REACHING OUT

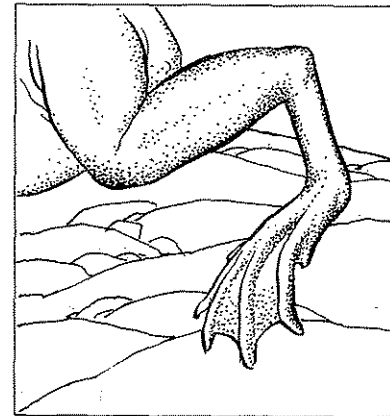


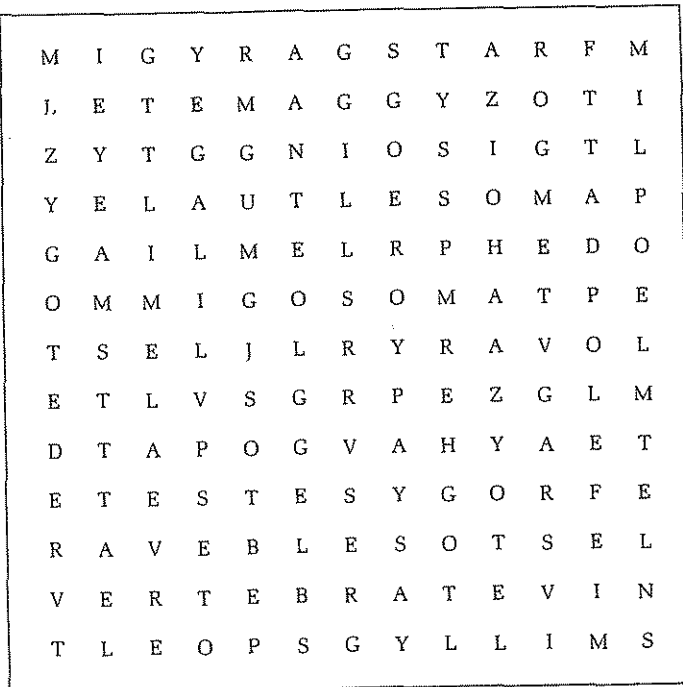
Figure L

A frog's hind legs are very powerful. They are also webbed.

1. What two important things does a frog do with his hind legs?

2. What does the webbing help a frog do? _____

WORD SEARCH The words in the list are hidden with the group of letters. Try to find each word. Then draw a line around the word when you find it. The spelling may go in any direction.



METAMORPHOSIS

TADPOLE

TESTES

ZYGOTE

GILLS

FROG

GAMETE

LUNGS

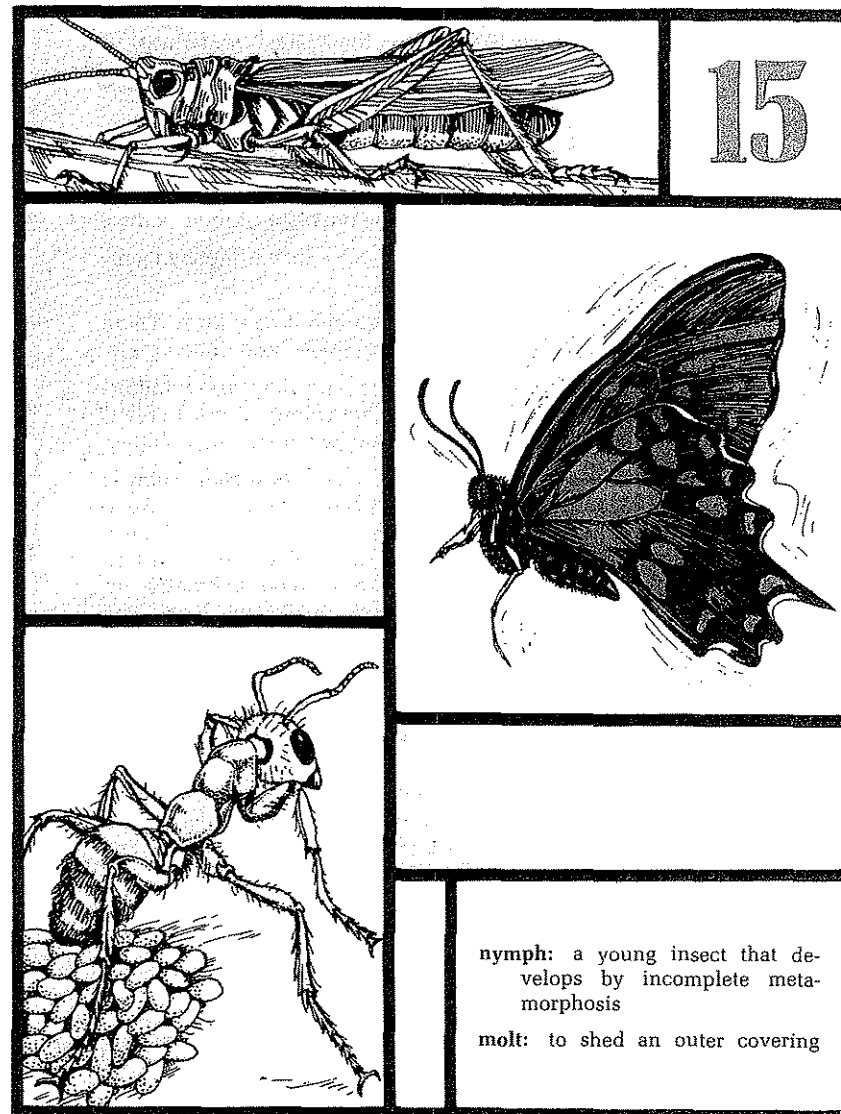
EGG

OVARY

MILT

VERTEBRATE

HOW DO INSECTS DEVELOP?



AIM | How do insects develop?

15

What is an insect? Many of the "bugs" you think of are not insects at all!

Insects can be identified by these characteristics:

- Insects have six jointed legs.
- Insects have three body sections.
- Insects have skeletons on the outsides of their bodies.
- Insects hatch from eggs and grow into adults by metamorphosis.

Metamorphosis means a change into a new form. There are two types of metamorphosis, complete and incomplete. **COMPLETE METAMORPHOSIS** Did you ever see a butterfly among the flowers? Just a short time before, it was a crawling caterpillar. The caterpillar changed form completely.

Some insects that develop by complete metamorphosis are butterflies, mosquitoes, flies, and bees. These insects have four stages in their development: egg, larva, pupa [PEW puh], and adult. The egg hatches into a larva (like a caterpillar). Then the larva becomes a pupa (like a cocoon). Finally out comes the adult. The adult looks nothing like the larva. The adults mate and the cycle starts all over again.

INCOMPLETE METAMORPHOSIS In incomplete metamorphosis, the change from the young stage to the adult stage is not so great. There are only three stages of development: egg, nymph [nimf], and adult.

Grasshoppers develop by incomplete metamorphosis. A young grasshopper is called a nymph. A nymph looks like an adult—only smaller. It has a large head but no wings. The wings develop as the nymph grows.

A nymph sheds or molts its outer covering about five times as it grows. Small wings appear after the first molt. The wings grow larger with each molt. The last molt produces an adult grasshopper with full wings.

BUTTERFLY DEVELOPMENT

Study Figure A. Then answer the questions.

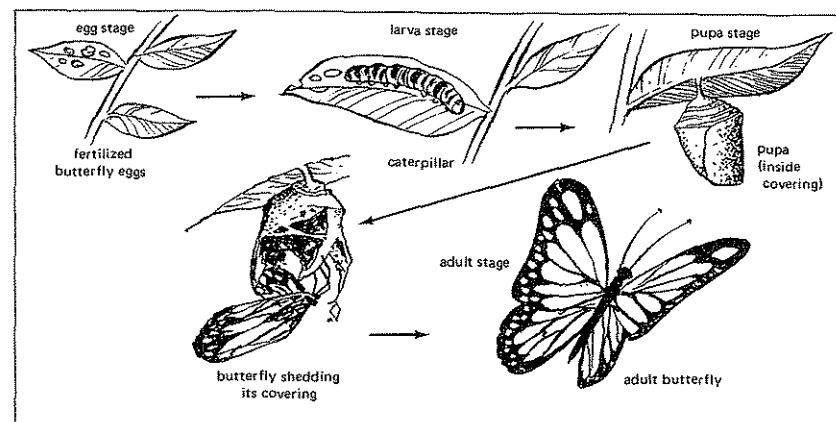


Figure A

1. What kind of animal is the butterfly? _____
2. Butterflies reproduce by _____ reproduction.
sexual, asexual
3. Where does a female butterfly lay her fertilized eggs? _____
4. Some animals change in form as they develop into adults what is this change called? _____
5. a) Do butterflies develop by metamorphosis? _____
b) What kind? _____
c) List the stages of this development. _____

6. Does the larva stage resemble the adult? _____
7. Does the pupa stage resemble the adult? _____
8. What is the common name of a butterfly's pupa stage? _____
9. A butterfly molts just once.
a) From which stage does a butterfly molt? _____
b) Into which stage does a butterfly molt? _____
10. During which stage do the greatest changes take place? _____

GRASSHOPPER DEVELOPMENT

Study Figure B. Then answer the questions.

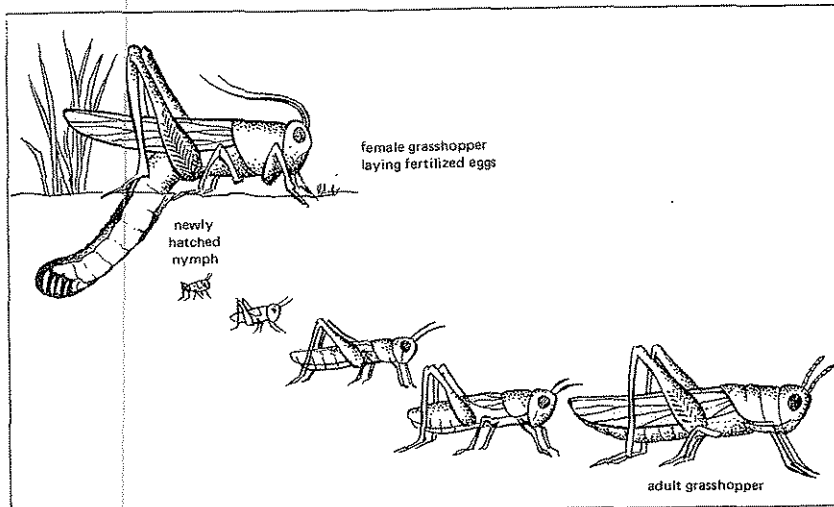


Figure B

1. What kind of animal is the grasshopper? _____
2. Grasshoppers reproduce by _____ reproduction.
sexual, asexual
3. Where does a female grasshopper lay her fertilized eggs? _____
4. a) Do grasshoppers develop by metamorphosis? _____
b) What kind? _____
c) List the stages of incomplete metamorphosis. _____

5. Does the nymph stage resemble the adult? _____
6. A nymph sheds its outer covering several times. What is another word for shed?

7. A nymph grasshopper grows in size. What part of its body is developing?

COMPLETING SENTENCES

Complete the sentences with the choices below.

three
do not
metamorphosis
mosquitoes
flies

adult
butterflies
six
grasshoppers
complete

bees
incomplete
eggs
molts

1. An insect has _____ jointed legs and _____ body sections.
2. Insects hatch from _____.
3. Insects change in form as they grow. This is called _____.
4. Egg, larva, pupa, and adult are the stages of _____ metamorphosis.
5. Larva and pupa stages _____ resemble the adult.
6. Four insects that develop by complete metamorphosis are _____, _____, _____, and _____.
7. Egg, nymph, and adult are the stages of _____ metamorphosis.
8. A nymph resembles the _____.
9. A nymph _____ about five times.
10. _____ develop by incomplete metamorphosis.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|----------------------------------|---------------------------------------|
| 1. _____ molt | a) a butterfly's larva stage |
| 2. _____ caterpillar | b) young grasshopper |
| 3. _____ nymph | c) stages of incomplete metamorphosis |
| 4. _____ egg, nymph, adult | d) to shed outer covering |
| 5. _____ egg, larva, pupa, adult | e) stages of complete metamorphosis |

SPELL THE MISSING WORD

Fill in the missing letters to spell the terms that fit the definitions.

When you have answered correctly, you will spell another term in the box.

1. _ e _ a o _ p _ o _ i _
2. _ _ _ c _ m _ l _ t _
3. _ _ _ a _ v _
4. _ d _ l _

1. a change into a new form
2. _____ metamorphosis
3. a fly egg hatches into one
4. last insect stage

REACHING OUT

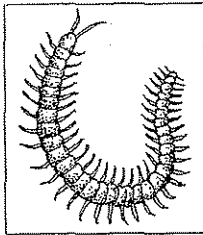


Figure C A centipede

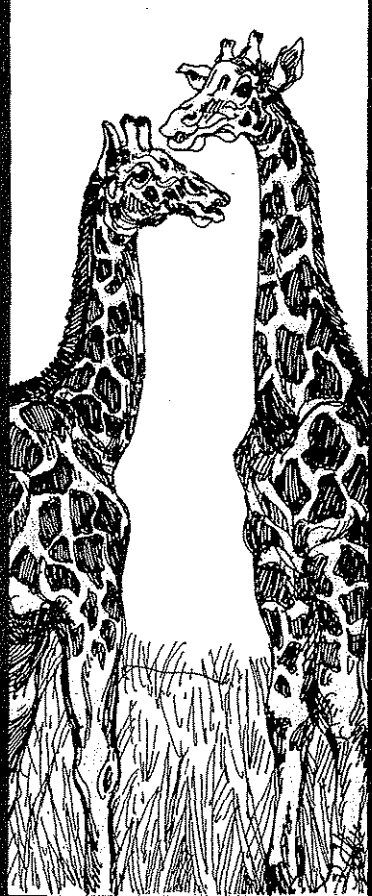
1. Are insect eggs fertilized inside or outside the female's body? _____
(Hint: The clues are in the diagrams.)
2. Are centipedes insects? _____
Why or why not? _____

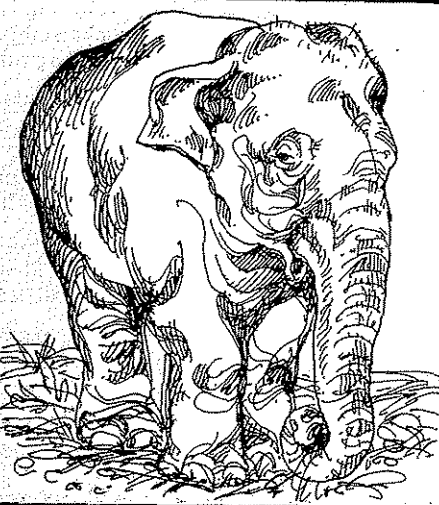
WHAT ARE TRAITS?





16





traits: characteristics that living things have

It is easy to recognize an elephant. An elephant is very large and has a long trunk. A giraffe is easy to recognize too—by its long neck.

The elephant's trunk and the giraffe's neck are examples of traits. Traits are characteristics that living things have. They help us to identify living things.

Scientists have divided plants and animals into groups according to traits. All members of a group have certain traits that are the same. For example, all birds have feathers. All mammals have some hair. All giraffes have long necks. And all elephants are large and have long trunks.

Organisms within a group may share certain traits. But no two are exactly alike. There are always *individual* differences. We call these differences *individual traits*.

Take the elephant for example. All elephants are large. But some are larger than others. All giraffes have long necks. But some giraffes have longer necks than others.

All humans share certain traits. But no two people are exactly alike—not even identical twins. There are always individual differences.

Individual differences enable us to identify different members of the same group.

Think of your friends, for example. You know one from another by their individual traits. They include differences in size, hair type and coloring, skin coloring, and shape of face. How many other individual human traits can you name?

IDENTIFYING LIVING THINGS BY GROUP TRAITS

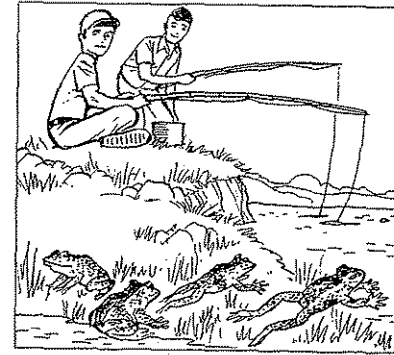


Figure A

Humans and frogs are alike in some ways. They share certain traits. For example:

- Both humans and frogs are living things. Therefore, both carry out the life functions.

- Both humans and frogs are animals.

- Both humans and frogs are vertebrates. They have backbones.

But humans and frogs are different from one another too—very different. We can tell humans from frogs by the traits they do not share.

Sixteen traits are listed below and on the next page. Some are human traits. Some are traits that frogs have.

Study each trait. Does it belong to humans or does it belong to frogs?

Write H next to each human trait. Write F next to each frog trait.

1. some hair covering _____
2. external fertilization _____
3. internal fertilization _____
4. embryos develop outside the female's body _____
5. females can nurse their young _____
6. give birth to live young _____
7. live entire life on land _____
8. live early part of life in water and adult life on land _____
9. breathe by lungs only _____
10. breathe through gills in early life _____
11. adults breathe by lungs or through skin _____
12. stand on two legs _____

13. stand on four legs _____
14. eat only insects _____
15. eat meat and vegetables _____
16. able to reason (a form of intelligent thinking) _____

Now answer these questions.

17. Do all humans have the traits you have listed as H? _____
18. Do all frogs have the traits you have listed as F? _____
19. The traits you have listed are _____ traits.
large group, individual
20. Do all humans belong to one group of vertebrates? _____
21. Do all frogs belong to one group of vertebrates? _____
22. a) Do humans and frogs belong to the same group of vertebrates? _____
b) Why? _____

IDENTIFYING INDIVIDUALS BY INDIVIDUAL TRAITS

Look at Figure B and answer the questions.

John, Jim, and Tom are humans. They are about the same age. They have all the traits that humans share. Yet, they are different from one another.

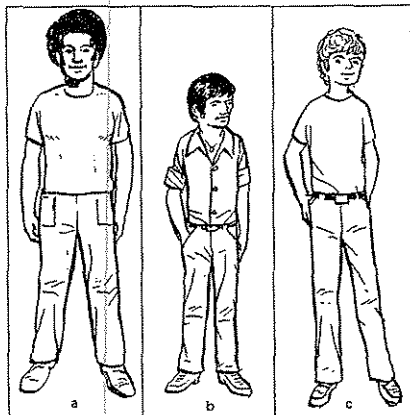


Figure B

■ John is short and thin. He has light-brown skin and dark straight hair.

■ Jim is tall and heavy. He has dark-brown skin and dark curly hair.

■ Tom is tall and thin. He has fair skin and light curly hair.

1. Identify by letter.
 - a) Which one is John? _____
 - b) Which one is Jim? _____
 - c) Which one is Tom? _____
2. a) Do all humans have hair? _____
b) Hair _____ a human trait.
is, is not
- c) Do all humans have the same color hair? _____
- d) Do all humans have curly hair? _____
- e) Do all humans have straight hair? _____
3. What kind of trait is hair color and type? _____
individual, group
4. At a given age, is every person the same height? _____
5. Are some people taller than average? _____
6. Are some people shorter than average? _____
7. Difference in height is what kind of trait? _____
individual, group

Figure C shows the easiest individual trait to identify.

8. Which letter shows Sally? _____
9. Which shows Gary? _____
10. Which individual trait is shown here? _____
11. a) Can you identify one-celled plants and animals by sex? _____
b) Why? _____

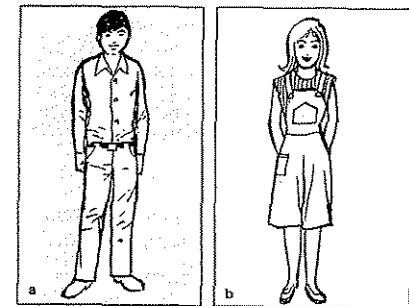


Figure C

Figure D shows two pea pods and their peas.

12. Are the peas of these pods exactly the same? _____

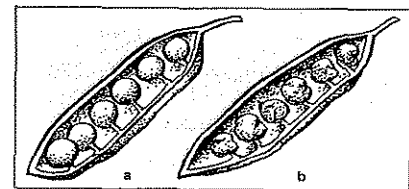


Figure D

13. What difference do you notice in the skins of the peas? _____

14. What kind of difference is this? _____
individual, group

COMPLETING SENTENCES

Complete the sentences with the choices below. Two of these may be used twice.

traits
humans
animals

the same
individual traits
individual

plants
exactly
identified

1. The characteristics a living thing has are called _____.
2. Living things are _____ by their traits.
3. Scientists group _____ and _____ by their traits.
4. Members of a group have certain traits that are _____.
5. No two living things are _____ the same.
6. Differences among individuals of the same group are called _____.
7. Having a spinal cord, and internal fertilization and embryo development are group traits of _____.
8. Hair color and body size are _____ of humans.
9. Having cellulose, roots, and stems are group traits of _____.
10. Wrinkled skin or smooth skin are _____ traits of peas.

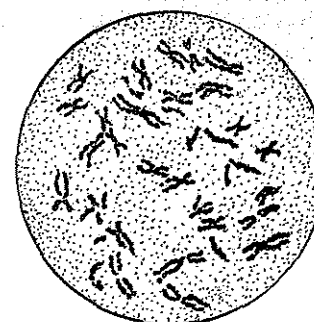
MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|----------------------------|------------------------------|
| 1. _____ traits | a) group trait of birds |
| 2. _____ feathers | b) individual human trait |
| 3. _____ color of feathers | c) human group trait |
| 4. _____ hair | d) clues to identification |
| 5. _____ hair texture | e) individual trait of birds |

WHAT ARE CHROMOSOMES?

17



inherit: to receive from a parent

chromosomes: tiny parts of a nucleus

genes: parts of chromosomes; genes carry the plans for heredity

DNA: a compound that makes up the material in genes

AIM | What are chromosomes?

17

"Mary has her mother's eyes." "Tom is built just like his father." How often have you heard remarks like these?

All people resemble their parents in some ways. They have similar traits. . . . And it is no accident. Many traits are passed on from parents to offspring. We say they are inherited. But how are they inherited? The answer is found in the cell nucleus.

Every nucleus has tiny bodies called **chromosomes** [KROME uh soamz]. Most are rod-shaped. Chromosomes, in turn, are made up of even smaller genes [JEENZ]. There are many, many genes—at least one million in every nucleus. **GENES DETERMINE THE TRAITS OF AN INDIVIDUAL.**

There are genes for height and build, genes for nose size and shape, genes for the color of hair, skin, and eyes. In fact, there are genes for most traits any individual has. Some genes even affect traits like voice, intelligence, and behavior.

"Body" cells are cells that are not sperm or egg cells. Chromosomes of body cells are found in **pairs**. One of each pair is inherited from the mother. The other one is inherited from the father. An individual, then, has chromosomes from both parents.

Each kind of organism has a certain number of chromosomes. For example, a fruit fly body cell has 8 chromosomes (4 pairs); a frog has 26 (13 pairs); a human has 46 (23 pairs); a garden pea has 14 (7 pairs).

Chromosomes in sex cells are **not** paired. Therefore, a gamete has half the number of chromosomes that a body cell has.

For example, a human body cell has 46 chromosomes. A human sperm or egg has one-half that number—23 chromosomes. How many chromosomes does a pea gamete have?

CHROMOSOMES AND GENES

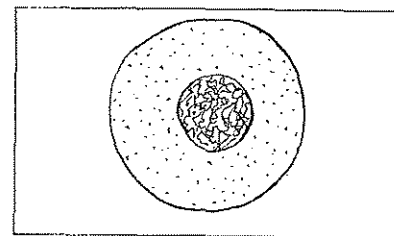


Figure A

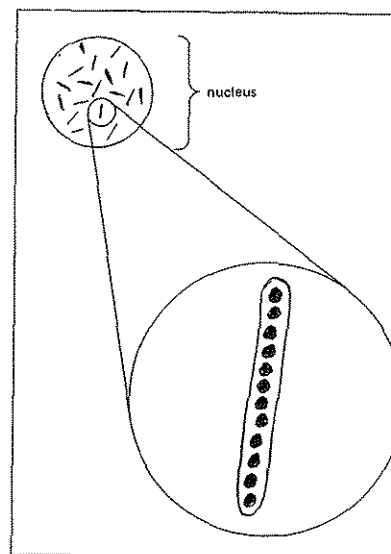


Figure B

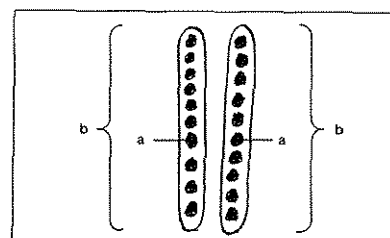


Figure C

Every cell has a nucleus.

- Figure A shows an animal cell.

a) Draw a line to the nucleus.

b) Label it "nucleus."

- A nucleus contains tiny rod-shaped bodies. What are they called?

- A chromosome is made up of even smaller bodies. What are they called?

- Figure C shows a pair of chromosomes and their genes.

a) The chromosomes are labeled

b) Two genes are labeled

- Why are genes important?

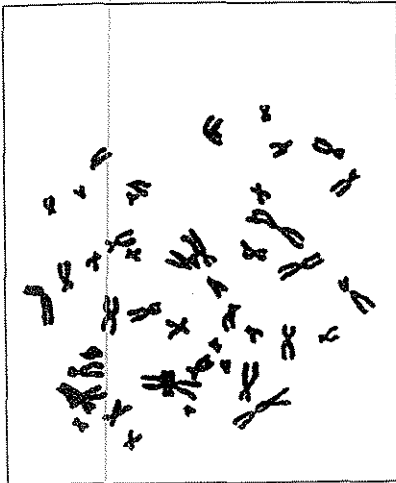


Figure D
Human chromosomes

Figure D shows what actual human chromosomes look like.

■ Every body cell of a particular organism has the same chromosomes.

■ No two individuals that reproduce sexually have the same chromosomes.

You have trillions of body cells. Each cell has the same chromosomes. No one else in the world has the same chromosomes. There is no "duplicate" of you—anywhere!

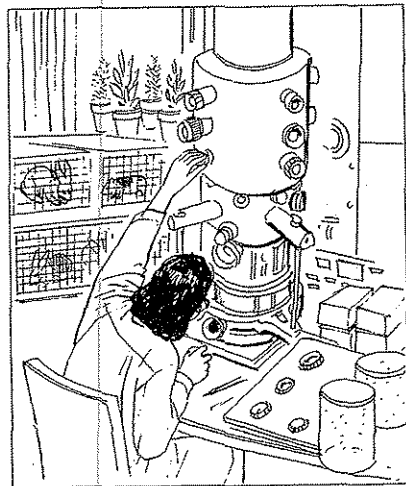


Figure E

The study of traits and how they are passed on is called *genetics* [juh NET icks].

- All living things have traits.
- All living things have genes.
- Only living things have genes.

The genes contain the "plans" for the traits an organism has.

What are genes made of?

Scientists have discovered that genes are made of a complicated compound called DNA. DNA stands for *deoxyribonucleic acid*. Try to pronounce it!

COMPLETING SENTENCES Complete the sentences with the choices below. Two of these may be used twice.

genes	46	specific
pairs	genetics	23
inherited	traits	chromosomes

- The characteristics an individual has are called _____.
- Traits are passed down from parents to offspring. Another way of saying this is "traits are _____."
- The study of heredity is called _____.
- Every plant and animal cell has tiny rod-shaped bodies called _____.
- A chromosome is made up of a chain of _____.
- Genes determine the _____ of an individual.
- Every organism has a _____ number of chromosomes.
- In body cells, chromosomes are found in _____.
- Each of your body cells has _____ pairs of chromosomes. This is a total of _____ single chromosomes.
- A human sperm or egg has _____ single chromosomes.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|----------------------|---------------------------------|
| 1. _____ genes | a) compound that makes up genes |
| 2. _____ chromosomes | b) made up of many genes |
| 3. _____ DNA | c) have unpaired chromosomes |
| 4. _____ body cells | d) pass on traits |
| 5. _____ gametes | e) have paired chromosomes |

NUMBER, PLEASE!

Fill in the missing number of chromosomes.

	Organism	Chromosomes in each body cell	Chromosomes in each sperm or egg
1.	Human	46	
2.	Horse	60	
3.	Housefly		6
4.	Dog	78	
5.	Grasshopper		7
6.	Mosquito		3
7.	Chicken	18	
8.	Apple		17
9.	Spinach	12	
10.	Lily		12

11. A gamete has _____ the number of chromosomes that a body cell has.
half, twice

12. How many pairs of chromosomes are there in each body cell of the following:

- a) horse _____ d) lily _____
b) mosquito _____ e) human _____
c) spinach _____ f) housefly _____

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Traits are the characteristics of living things.
2. _____ Only animals have traits.
3. _____ Traits are passed on from offspring to parents.
4. _____ Traits are passed on by genes.

5. _____ A cell has only a few genes.
6. _____ Only animals have genes.
7. _____ Different genes control different traits.
8. _____ Genes form chromosomes.
9. _____ Every organism has the same number of chromosomes.
10. _____ Body cells have paired chromosomes.
11. _____ Gametes have paired chromosomes.
12. _____ A body cell and a sex cell have the same number of chromosomes.
13. _____ Gametes have half the number of chromosomes of body cells.
14. _____ A human body cell has a total of 23 chromosomes.
15. _____ A human gamete has 23 single chromosomes.

CONNECTING DOTS Each player draws a line. If the line completes a box, then the player goes again. Put your initials in the boxes you complete.

```

. . . . .
. . . . .
I N H E R I T
. . . . .

. . . . .
S . . . . N
. . . . .
P . . E G G U
. . . . .
E . . . . C
. . . . .
R G E N E L
. . . . .
M . . . . E
. . . . .
. . . . . U
. . . . .
T R A I T S
. . . . .
. . . . .

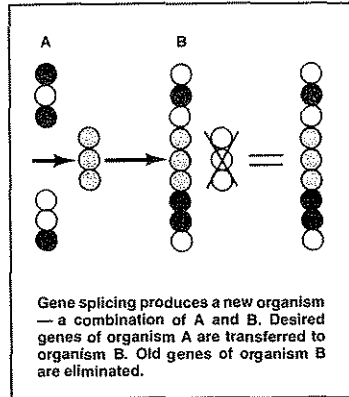
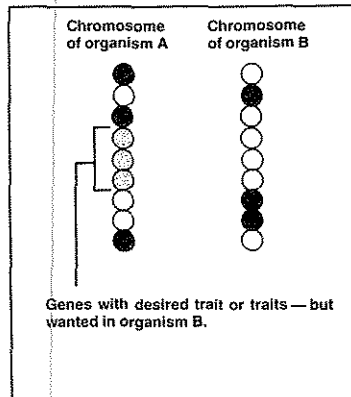
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Scoring:
empty box counts 1 point
box with a letter counts 2 points
add 10 points for each complete word

SCORE

Name _____ Name _____

KEEPING UP WITH SCIENCE



LAB-MADE BACTERIA

A chromosome is made up of a string of beadlike genes. It is the genes that carry the information to produce any trait. Now scientists have learned to identify the gene (or genes) for a particular trait. With this information they are able to map the genes on a chromosome.

More recently, scientists have learned how to transfer genes from one species of bacteria to another. They recombine genes. They splice a gene from one kind of bacteria into the chromosome of another kind of bacteria. Gene-splicing, as it is called, creates organisms not found in nature. They are tailor-made to do certain things.

For example, lab-made bacteria have been created to produce a substance like insulin. Another bacteria now produces an essential growth hormone, and another produces interferon. This chemical is pro-

duced in the body to fight disease. One injection of interferon costs about \$150. Bacteria "assembly lines" could bring down the price to \$1.

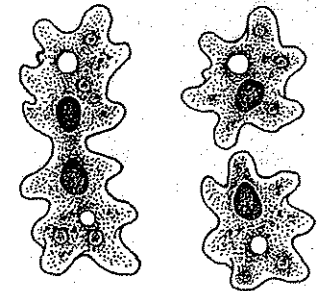
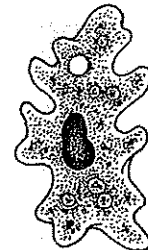
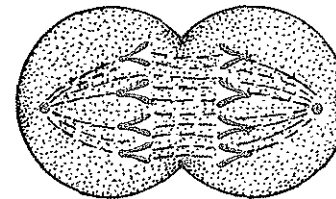
Bacteria have also been created that digest oil. In the future they may be able to clean up oil spills on the oceans and beaches.

Some biologists believe that gene splicing can create bacteria that can produce vaccines against such diseases as malaria and hepatitis. Other biologists believe they can use lab-made bacteria that will convert wastes into fuels, plastics, and other useful products.

Can gene splicing be used to produce crops that resist disease and discourage insect attack? And why not crops that thrive in drought and temperature extremes? Such questions are now being explored.

HOW ARE TRAITS PASSED ON IN ASESEXUAL REPRODUCTION?

18



mitosis: cell divisions by all cells except sex cells

centriole: a part of an animal cell

AIM | How are traits passed on in 18 | asexual reproduction?

An ameba reproduces by fission. This is a form of asexual reproduction. The offspring is exactly like the parent. A mold reproduces asexually too—by spores. And every new mold is the same as the parent.

Asexual reproduction produces offspring that are duplicates of their parents. There are, of course, some differences. But they are minor—and unimportant.

Why are the offspring of asexual reproduction exact copies of their parents?

In asexual reproduction, there is no link-up of sex cells. In fact, there are no sex cells. There is only one parent—and one set of chromosomes and genes. There is no mixing of genes. The genes are passed on without change when the cells divide.

“Body” cells are all cells except sex cells. Body cells divide by a process called *mitosis* [mie TOE sis].

In asexual reproduction, there are only body cells. Therefore, they divide only by mitosis.

During mitosis, a cell copies, or duplicates, its own chromosomes. One set of chromosomes becomes two sets. Each set is alike.

When the cell divides:

- One set of chromosomes becomes part of one cell.
- The other set of chromosomes becomes part of the other cell.

Each new cell is exactly alike—exact same chromosomes, exact same genes, exact same traits.

Body cells of all organisms divide by mitosis—not just organisms that reproduce asexually.

In sexual reproduction, a sperm or pollen fertilizes an egg. Many cell divisions follow. Each one is by mitosis.

UNDERSTANDING MITOSIS

Let us study mitosis of a typical animal cell.

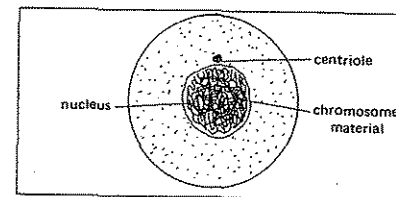


Figure A

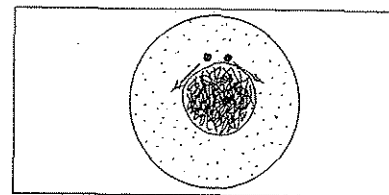


Figure B

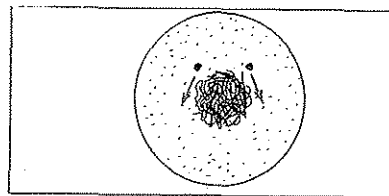


Figure C

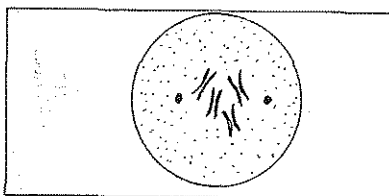


Figure D

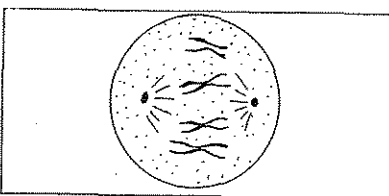


Figure E

This cell has four chromosomes. Follow what happens step-by-step.

■ The cell is getting ready to divide.

■ The chromosome material is duplicating itself. It does not look like chromosomes—not yet.

■ The centriole [SEN tree ole] divides. (Centrioles are found only in animal cells.)

■ The halves move towards opposite ends of the nucleus.

■ The chromosome material becomes threadlike and thicker.

■ The chromosomes are starting to take shape.

■ The chromosome pairs are now formed. They can be seen clearly. Count them.

■ Duplication is now complete. There are now two exact sets of chromosomes.

■ The two sets of chromosomes line up in opposite rows.

AIM | How are traits passed on in 19 | sexual reproduction?

In asexual reproduction there is only one parent, one set of chromosomes, and one set of genes. There is no mixing of genes. The same genes are duplicated over and over again. The offspring is just like the parent.

Sexual reproduction is different. In sexual reproduction, there are two parents, two sets of chromosomes, and two sets of genes. There is mixing of genes. The offspring inherits traits from both parents.

Think of yourself, for example. In some ways you are like your mother. In other ways you are like your father. You have inherited traits from *both* your parents.

Someday you may marry and have children. Where will your children's traits come from?

Let's see how chromosomes and genes become "mixed."

The chromosomes of body cells are paired. The chromosomes of sex cells are not paired. Chromosomes of sex cells are single chromosomes. Therefore, a sperm or an egg has one half the chromosomes and genes of a body cell.

When fertilization takes place, the sperm chromosomes join the egg chromosomes. Together, they add up to the full number of chromosomes found in body cells.

The fertilized egg, or zygote, now has chromosomes from both parents. It also has traits from both parents.

ONLY HALF THE STORY!

The cells in our bodies divide by mitosis. But sperm and egg cells do not divide this way. They divide by meiosis [my OH sis]. In meiosis, the pairs of chromosomes split apart. Each gamete has only *half* the usual number of chromosomes. But when the sperm and egg join, the zygote has the full number of chromosomes.

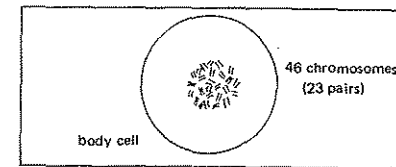


Figure A

A human body cell has 46 chromosomes. The chromosomes are paired. So there are 23 pairs.

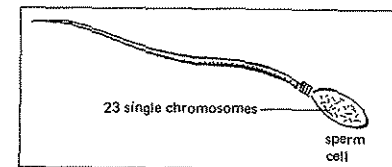


Figure B

Each human sperm cell has 23 single chromosomes.

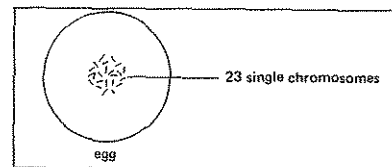


Figure C

Each human egg cell has 23 single chromosomes.

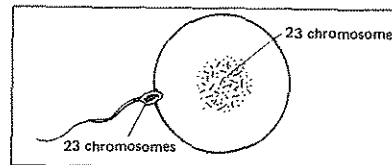


Figure D

Fertilization links the gamete chromosomes.

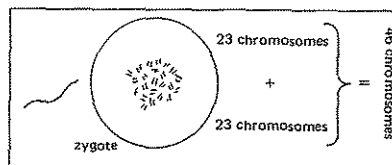


Figure E

The zygote, then has a total of 46 chromosomes. 23 are from the mother, 23 are from the father.

The zygote starts to divide after fertilization. It divides by mitosis. It divides over and over again as it develops.

UNDERSTANDING CHROMOSOME MIXING

Example: The fruit fly



Figure F
A fruit fly

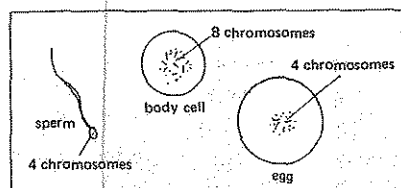


Figure G

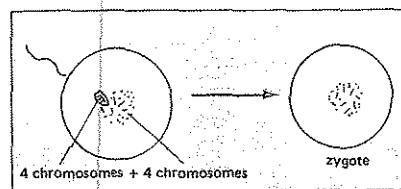


Figure H
A sperm fertilizes an egg.

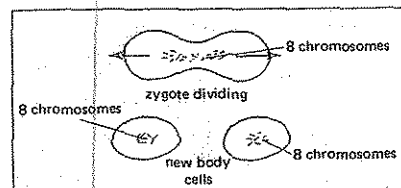


Figure I
The zygote divides. Then each new cell divides.

Scientists often study fruit flies because they have large chromosomes that are easy to count.

■ Every body cell of a fruit fly has 8 chromosomes.

■ Every fruit fly gamete (sperm or egg) has 4 chromosomes.

- Body cells reproduce by a process called _____.
- Gamete cells are formed by a process called _____.
- What are chromosomes made of? _____
 - What do they control? _____
- Fertilization produces a single cell. What is this cell called? _____
- How many chromosomes does a fruit fly zygote have? _____
 - A zygote is really an organism's first _____ cell.
body, sex
- What will *finally* develop? _____
- How many chromosomes will each body cell have? _____
- The offspring will have traits of the mother and the father. Why? _____

COMPLETING SENTENCES Complete the sentences with the choices below. One of these may be used twice.

one set
body cell
two
mitosis

zygote
without change
one
is

mixing
one half
meiosis

- Asexual reproduction passes on traits _____.
- In asexual reproduction, _____ of chromosomes and genes are passed on from cell to cell.
- In asexual reproduction, there is only _____ parent. There is no _____ of genes.
- In sexual reproduction, there are _____ parents. There _____ mixing of genes.
- Gamete cells are produced by cell division called _____.
- A sperm or egg cell has _____ the chromosomes of a body cell.
- A fertilized egg has chromosomes and genes from _____ parents.
- A fertilized egg is called a _____.
- A zygote is an organism's first _____.
- After fertilization, cells divide by _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-----------------------------|--|
| 1. _____ mitosis | a) produces gametes |
| 2. _____ meiosis | b) joins male and female chromosomes |
| 3. _____ gamete chromosomes | c) body-cell division |
| 4. _____ fertilization | d) organism's first body cell |
| 5. _____ zygote | e) have one half the number of body-cell chromosomes |

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Every cell has chromosomes.
2. _____ Chromosomes are found in a cell's cytoplasm.
3. _____ Chromosomes are made up of genes.
4. _____ Genes carry the messages of heredity.
5. _____ Every organism has the same kind of genes.
6. _____ Every organism has the same number of chromosomes.
7. _____ Every body cell of a mosquito has the same number of chromosomes.
8. _____ A gamete has the same number of chromosomes as a body cell.
9. _____ A gamete has twice the number of cells as a body cell.
10. _____ A frog gamete has 13 chromosomes. Every frog body cell, then, has 26 chromosomes.

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

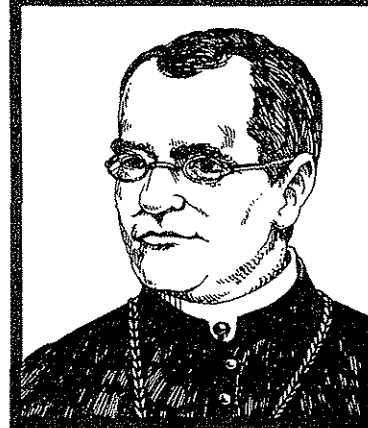
1. TOSSIMI _____
2. NEEG _____
3. ROOMMECOSH _____
4. IPAR _____

REACHING OUT

Why must a gamete have one half the number of chromosomes found in body cells?

WHAT ARE DOMINANT AND RECESSIVE TRAITS?

20



dominant trait: the trait that shows up when the gene for the opposite trait is also present

recessive trait: the trait that does not show up when the dominant trait is present

AIM | What are dominant and recessive traits?

Tom has dark hair—just like his parents. Sally's hair is dark too—just like her father. But her mother's hair is blonde.

It is easy to understand why Tom's hair is dark. Both his parents have dark hair. But what about Sally? Why is her hair dark? Why not blonde?

This kind of question was first answered in the mid-1800's by Gregor Mendel, an Austrian monk. Mendel observed inherited traits. He wondered why certain traits found in parents show up in their offspring—while other traits do not.

To find the answer, Mendel experimented with pea plants. He observed certain traits such as tallness and shortness, color, and the smoothness of the seed coverings. His experiments led to the *Laws of Heredity*. They hold true for all organisms that reproduce sexually.

One of Mendel's laws is called the *Law of Dominance*. This is what it states:

1. Every trait has genes from both parents.
2. If the genes are alike (like two "tall" genes), the offspring will inherit that trait. THERE IS NO OTHER POSSIBILITY.
3. If the genes are opposite (like a "tall" gene and a "short" gene), then one trait will show up in the offspring. The other trait will not, it will be "hidden."

The "hidden" gene is called the *recessive* [ree SESS iv] gene for that trait. The gene that shows up is the *dominant* gene.

Let's look at Sally again. Sally has genes for dark hair and for light hair. But dark hair is dominant over light hair. That is why Sally's hair is dark.

It is interesting to note that a trait that is dominant for one kind of organism may be recessive in another.

UNDERSTANDING MENDEL'S EXPERIMENTS

What You Need To Know:

■ A pure line is an organism whose genes for a certain trait are the same from both parents.

■ A pure line may have two dominant genes or two recessive genes.

Examples: having genes only for tallness or genes only for shortness.

A hybrid is an organism whose genes for a certain trait are not the same.

Example: having genes for tallness as well as genes for shortness.

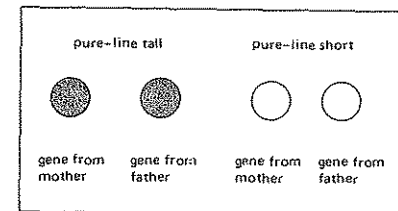


Figure A

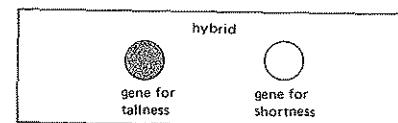


Figure B

No organism has all dominant or all recessive genes.

An organism may be pure in certain traits and hybrid in others. Figures C through F show some of Mendel's experiments with pea plants. Study the figures and answer the questions with each.

Circle the letter of the phrase that completes each sentence best. Fill in the answer blanks for the other sentences.

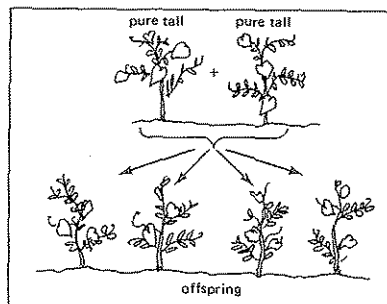


Figure C

Mendel cross-pollinated two pure-line tall pea plants.

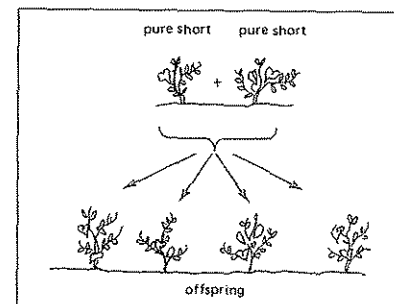


Figure D

Then, Mendel crossed two pure-line short pea plants.

1. Offspring of pure-line tall pea plants are
 - a) only tall.
 - b) only short.
 - c) tall and short.
2. Offspring of pure-line short pea plants are
 - a) only tall.
 - b) only short.
 - c) tall and short.

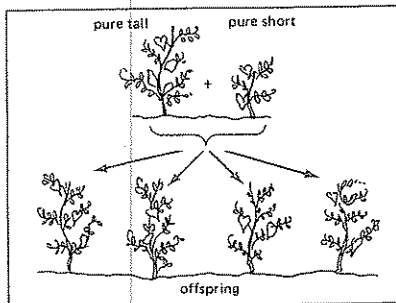


Figure E
Next, Mendel crossed a pure-line tall with a pure-line short.

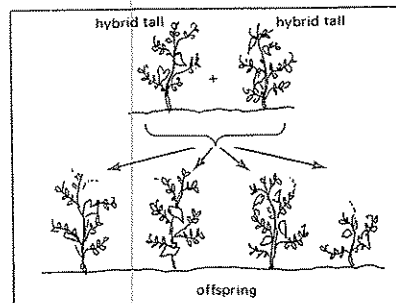


Figure F
Mendel then crossed hybrid-tall plants.

Look at Figure F.

9. a) Which trait is recessive? _____

b) Is the recessive trait always hidden? _____

c) How many plants are tall? _____

d) How many plants are short? _____

10. Complete the fractions in these sentences:

When you cross hybrids, the dominant trait shows up $\frac{\boxed{4}}{4}$ of the time.

The recessive trait shows up $\frac{\boxed{4}}{4}$ of the time.

3. Offspring of pure-line tall pea plants and pure-line short plants are
 - a) only tall.
 - b) only short.
 - c) short and tall.
4. We see that in pea plants, shortness, tallness is dominant over shortness, tallness.
5. The offspring now carry genes of height from both parents. They are
 - a) genes only for tallness
 - b) genes only for shortness
 - c) genes for tallness and shortness
6. The offspring are pure line, hybrid.
7. Offspring of hybrid-tall pea plants are
 - a) only tall.
 - b) only short.
 - c) short and tall.
8. a) Which is the dominant trait? _____

b) Does the dominant trait show up in every offspring? _____

DOMINANT AND RECESSIVE TRAITS IN HUMANS

How many traits do you recognize in yourself?

Dominant	Recessive
brown eyes	blue eyes
very curly hair	wavy hair
wavy hair	straight hair
freckles	no freckles
nearsightedness	normal eyesight
long eyelashes	short eyelashes
large ears	small ears
dimpled cheeks	no dimples

Predicting Human Traits

Now use the information from the chart above to fill in the chart below. The first example has been done for you.

	Mother	Father	Offspring	Dominant or Recessive?	Hybrid or Pure?
1.	normal eyes	nearsighted	nearsighted	dominant	hybrid
2.	straight hair	straight hair			
3.	long eyelashes	short eyelashes			
4.	no freckles	no freckles			
5.	no dimples	dimples			
6.	blue eyes	brown eyes			
7.	large ears	large ears			
8.	wavy hair	very curly hair			

Now answer these questions.

9. How many offspring will be pure recessive for a trait? _____
10. Why will the recessive genes show up? _____

COMPLETING SENTENCES

Complete the sentences with the choices below. Two of these may be used twice.

hybrid
recessive
garden peas

Gregor Mendel
genes
the same

dominant
pure line
two

1. A pioneer in the study of heredity was _____.
2. Mendel studied heredity by experimenting with _____.
3. Traits are controlled by _____.
4. In organisms that reproduce sexually, every trait has genes from _____ parents.
5. The "stronger" of the two traits which show up in an organism is called a _____ trait.
6. The "weaker" of two traits is called a _____ trait.
7. No organism has all _____ or all _____ genes.
8. An organism whose genes for a trait are the same is called _____ for that trait.
9. An organism whose genes for a trait are not the same, is called _____ for that trait.
10. An offspring will definitely inherit a trait if both his genes for that trait are _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--------------------------|--|
| 1. _____ dominant trait | a) has mixed genes for a given trait |
| 2. _____ recessive trait | b) shows up in offspring |
| 3. _____ pure line | c) a dominant trait in pea plants |
| 4. _____ hybrid | d) has similar genes for a given trait |
| 5. _____ tallness | e) remains hidden |

HOW CAN WE PREDICT HEREDITY?

21



	D	D
D		
d		

Punnett square: a chart that helps us predict heredity

AIM | How can we predict 21 | heredity?

Meet Mr. and Mrs. Jones:



TOM



and



SUSAN



Tom has pure-line genes for dark hair.

Susan has hybrid genes for hair color, one dominant dark gene for dark hair and one recessive gene for blonde hair.



How can we predict what color hair their children will have? It's easy! We can use a special chart called a Punnett square.

1. Mark Tom's genes on the top of the chart. A dominant gene is marked with a capital letter. "D" stands for dominant dark hair. Both of Tom's genes for hair color are D.

		male gametes	
		D	D
female gametes	D		
	d		

2. Mark Susan's genes on the side of the chart.

Susan is hybrid dark for hair color. One gene is D. The other gene is the recessive blonde (d). A recessive gene is always marked with a small letter.

	D	D
D	DD	DD
d	Dd	Dd

3. Now mark each box with the letters that meet there.

Each box now shows the different combination of genes that can show up in the offspring.

MORE ON TOM AND SUSAN

Look again at the chart on the facing page. What do the letters in the box tell us?

- The possibilities of gene mixing are DD, DD, Dd, and Dd.
- Each combination has a dominant dark hair gene.
- Therefore all of Tom and Susan's children will have dark hair.

If Tom and Susan have four children,



DD



DD

... two may be pure line for dark hair.



Dd



Dd

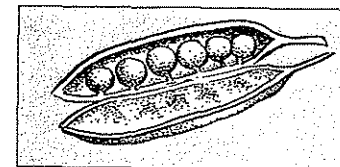
... two may be hybrid for dark hair.

But remember, there are only two possibilities—pure dark and hybrid dark. And you cannot tell by looking at the children which is pure line and which is hybrid!

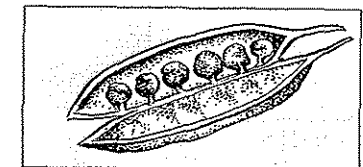
Which one will turn up? It's a matter of chance.

PREDICTING HEREDITY IN PEA PLANTS

When Mendel did his experiments with pea plants he found that some peas had a smooth covering. Others were wrinkled.



Smooth peas are dominant (S).



Wrinkled peas are recessive (s).

Let's see what happens when a pure smooth is crossed with a pure wrinkled pea plant.

1. The dominant smooth genes came from the _____

male, female

2. The recessive wrinkled genes come from the _____

male, female

3. The genes for smooth peas are _____
pure line, hybrid

4. The genes for wrinkled peas are _____
pure line, hybrid

5. Now fill in Figure A.

6. a) What kind of covering will all the offspring peas have? _____
smooth, wrinkled

- b) All the offspring are _____
pure line, hybrid

7. Would there be any difference if the S genes were female and the s genes were male? Test it in Figure B.

Answer: There _____ be a difference.
would, would not

Now try a hybrid cross, Ss × Ss.

8. Fill in Figure C.

9. a) How many offspring are smooth? _____

- b) How many are wrinkled? _____

10. a) How many offspring are pure line? _____

- b) How many are pure-line smooth? _____

- c) How many are pure-line wrinkled? _____

11. How many offspring are hybrid smooth? _____

PREDICTING HUMAN TRAITS

Gary and Tina are married. They are planning a family. What will their children look like?

Gary is hybrid for curly hair (Cc). Tina is pure for straight hair (cc).

C = dominant curly
c = recessive straight

Gary is hybrid for dark hair (Dd). Tina is pure for blonde hair (dd).

D = dominant dark
d = recessive blonde

Both Gary and Tina are hybrid for brown eyes (Bb).

B = dominant brown
b = recessive blue



Figure D

Complete the chart for each trait.

HAIR TYPE	
Gary's gametes	
C	c
Tina's gametes	C
	c

Figure E

HAIR COLOR	
Gary's gametes	
D	d
Tina's gametes	D
	d

Figure F

EYE COLOR	
Gary's gametes	
B	b
Tina's gametes	B
	b

Figure G

You filled in the Punnett squares for each trait. You saw the different combinations that are possible for each.

So what traits will Gary and Tina's children have? Here are the possibilities. But remember: THESE ARE *JUST* POSSIBILITIES.

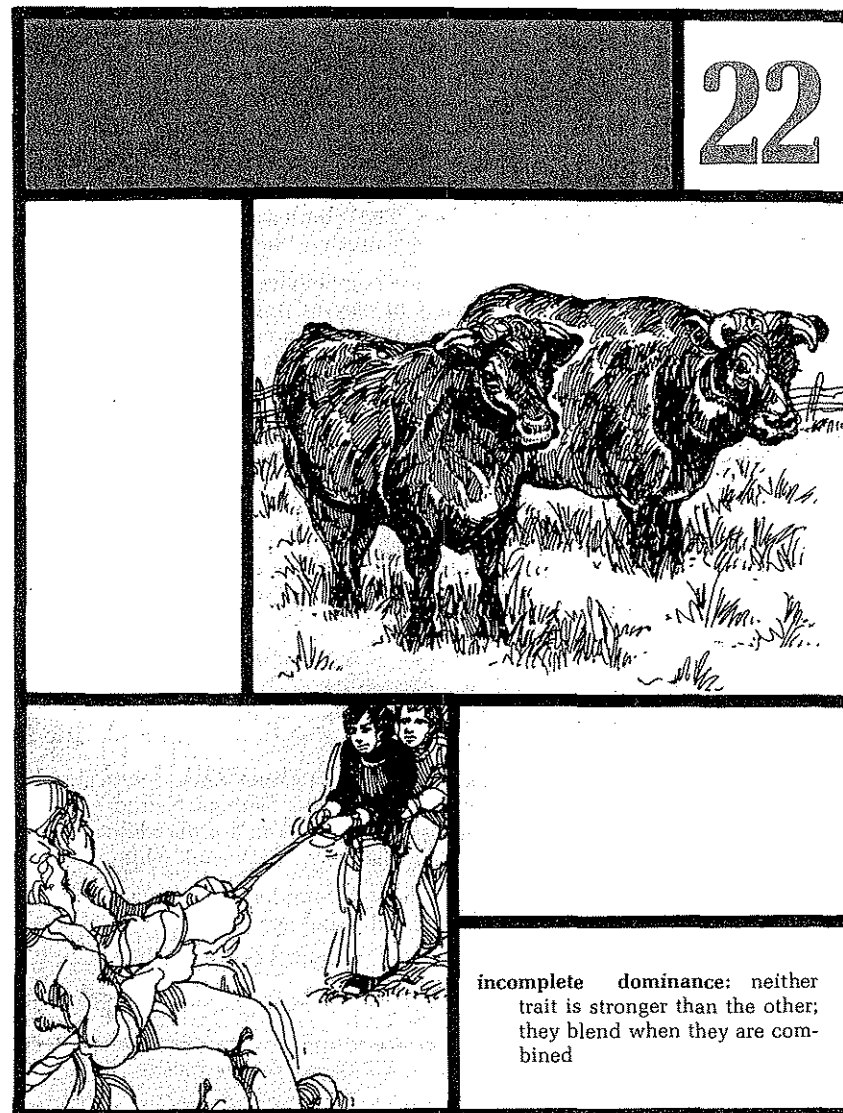
Offspring	Hair Type	Hair Color	Eye Color
#1	Cc	Dd	BB
#2	cc	dd	Bb
#3	Cc	Dd	Bb
#4	cc	dd	bb

Now use this information to predict what Gary and Tina's children will look like. Fill in the chart below.

Offspring	Hair		Eyes
	Curly or Straight	Dark or Light	Blue or Brown
#1			
#2			
#3			
#4			

WHAT IS INCOMPLETE DOMINANCE?

22



AIM | What is incomplete dominance?

22

In most games, there is a stronger team and a weaker team. Usually, the stronger team wins. But some games end in draws. This shows that the teams were equally matched.

Heredity is something like this. Most traits have a stronger, dominant gene, and a weaker, recessive gene. The dominant gene usually "wins." The dominant trait shows up in the offspring. The recessive trait stays "hidden."

Not all genes, however, are completely dominant nor completely recessive. The genes of certain traits are equally strong. Neither trait is dominant. We say there is *incomplete dominance*. In such cases, the traits "blend." The trait that shows up is somewhere between the two traits.

Three good examples of incomplete dominance are found in the colors of four-o'clock flowers, shorthorn cattle, and Andalusian fowl.

FOUR-O'CLOCK FLOWERS Four-o'clock flowers are usually red or white. Red and white are equally strong traits. Neither color is dominant. When a pure red (RR) crosses with a pure white (WW), the colors blend. The offspring have pink flowers (RW).

SHORTHORN CATTLE In cattle, if one parent is pure red (RR) and the other parent is pure white (WW), the offspring will be pink—an even blend of red and white (RW). The "blended" calf is called a roan calf.

ANDALUSIAN FOWL Some of these chickens have genes for black feathers. Others have genes for white feathers. Neither color is dominant. The offspring of pure black and pure white Andalusians are gray. Gray is a blend of black and white.

Many genes in humans show incomplete dominance. They include genes for most hair, skin, and eye colors.

UNDERSTANDING BLENDING

Figures A, B, and C show three examples of incomplete dominance. Look at the pictures and answer the questions below each.

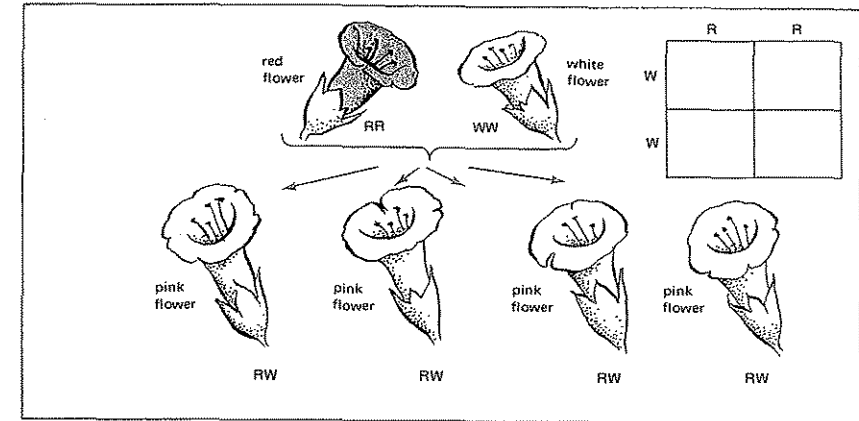


Figure A The crossing of pure red (RR) and pure white (WW) four-o'clock flowers

Fill in the Punnett square in Figure A. Then answer by filling in the blanks.

1. The offspring of crossed pure red and pure white four-o'clock flowers are 1. _____
 - a) only red.
 - b) only white.
 - c) only pink.
2. In four-o'clock flowers, 2. _____
 - a) red is dominant over white.
 - b) white is dominant over red.
 - c) neither red nor white is dominant.
3. Pink is a blend of which two colors? _____
4. Blending is caused by _____ of the genes of a certain trait.
5. Blended four-o'clock flowers have 5. _____
 - a) only white genes.
 - b) only red genes.
 - c) white genes and red genes.
6. Blended four-o'clock flowers are _____

pure line, hybrid
7. Just by looking at the chart in Figure A how can you tell that there is incomplete dominance? _____

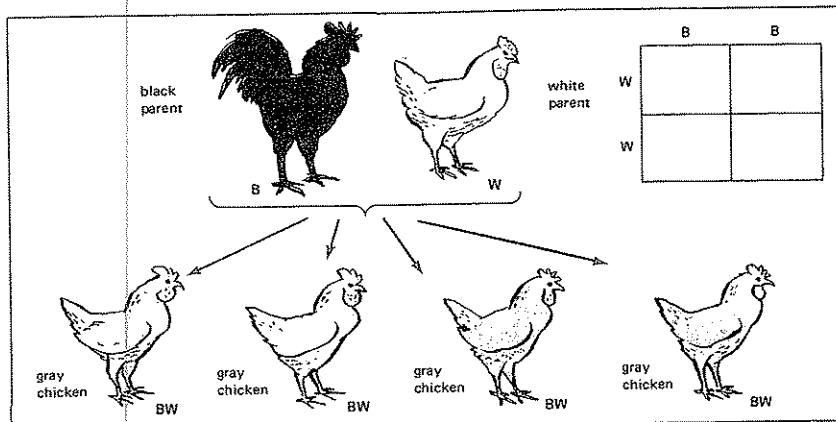


Figure B

The crossing of pure black (BB) and pure white (WW) Andalusian chickens

8. Complete the chart in Figure B.
9. The offspring of crossed pure black and pure white Andalusian chickens are _____
 a) only white.
 b) only black.
 c) a blend of black and white.
10. In Andalusian chickens, _____
 a) black is dominant over white.
 b) white is dominant over black.
 c) neither black nor white is dominant.
11. What color are the offspring of these matings? _____
12. Gray is a blend of which two colors? _____
13. Blended Andalusian fowl have _____
 a) only black genes.
 b) only white genes.
 c) black genes and white genes.
14. Blended Andalusian fowl are _____
 pure line, hybrid

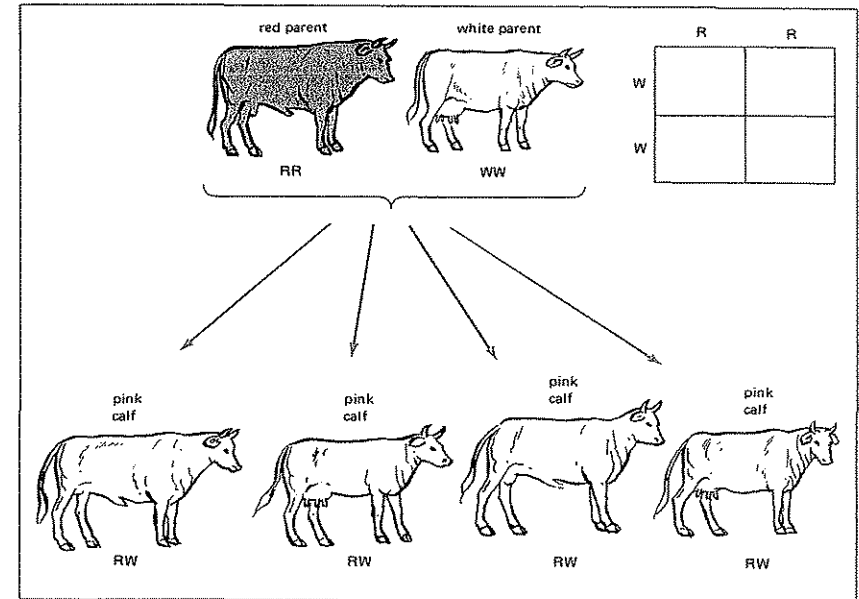


Figure C

The crossing of pure red (RR) and pure white (WW) shorthorn cattle.

15. Complete the chart in Figure C.
16. The offspring of crossed pure red and pure white shorthorn cattle are _____
 a) only red.
 b) only white.
 c) a blend of red and white.
17. In shorthorn cattle, _____
 a) red is dominant over white.
 b) white is dominant over red.
 c) there is incomplete dominance of red and white colors.
18. What are red and white blended cattle called? _____
19. Roans have _____
 a) only white genes.
 b) only red genes.
 c) white and red genes.
20. Roans are _____
 pure line, hybrid

COMPLETING SENTENCES

Complete the sentences with the choices below. One of these may be used twice.

blends	dominant	incomplete dominance
roan calf	red	skin
recessive	eye	pure line
white	pink four-o'clock flower	hybrid

- A trait that appears in an offspring is called a _____ trait.
- A hidden trait is called a _____ trait.
- An individual that has only dominant or recessive genes for a trait is _____ for that trait.
- An individual that has both dominant and recessive genes for a trait is _____ for that trait.
- A condition where the genes for a given trait are equally strong is called _____.
- Incomplete dominance _____ the characteristics of a trait.
- Two examples of offspring of incomplete dominance are the _____ and _____.
- In four-o'clock flowers and roan cattle, neither the color _____ nor _____ is dominant.
- Incomplete dominance produces offspring with _____ genes for the given trait.
- Examples of incomplete dominance in humans are found in _____ and _____ color.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-------------------------------|---------------------|
| 1. _____ RR | a) recessive pure |
| 2. _____ Rr | b) control heredity |
| 3. _____ rr | c) blends traits |
| 4. _____ incomplete dominance | d) dominant pure |
| 5. _____ genes | e) hybrid |

REACHING OUT

Roan cattle are hybrid for color (RW).

Suppose you mated roan cattle. What color would their offspring have? Would they all be roans?

Find the answers by filling in the chart. Then answer the questions below.

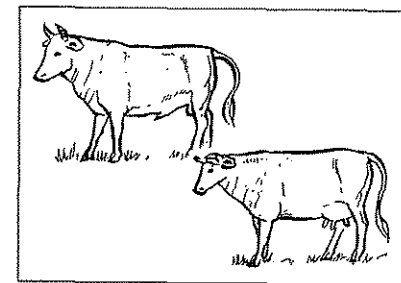


Figure D

	R	W
R		
W		

- Of four offspring,
 - how many are red? _____
 - how many are white? _____
 - how many have blended color? _____
 - The red offspring are _____ pure line, hybrid.
 - The white offspring are _____ pure line, hybrid.
- How many offspring are roans? _____
 - How many offspring are not roans? _____
 - Which ones are not roans? _____, _____
- Do roans reproduce only roans? _____

WORD Unscramble each of the following to form a word or term that
SCRAMBLE you have read in this Aim.

1. TOMANDIN _____
2. SEERVICES _____
3. DLEBN _____
4. RATTI _____

HOW IS SEX DETERMINED?

23

		Eggs	
		X	X
Sperm	X	XX	XX
	Y	XY	XY



XX: female sex chromosomes
 XY: male sex chromosomes

AIM | How is sex determined?

23

Will the baby be a boy or a girl? Every expectant parent asks this question. Well, the possibilities are even—50 percent for a boy, 50 percent for a girl. It depends entirely upon chance.

A single family may have more girls than boys, or more boys than girls. But the population on the whole is just about even—half male and half female. Let us examine why. We will use the fruit fly as an example.

A fruit fly body cell, you remember, has eight chromosomes (four pairs). Two of these (one pair) are sex chromosomes.



Chromosomes from a body cell of a male fruit fly



Chromosomes from a body cell of a female fruit fly

Notice that each chromosome pair is matched in size and shape—except for the sex chromosomes.

Notice also that sex chromosomes come in two shapes.



This is called an X chromosome.



This is called a Y chromosome.

A female body cell has two X chromosomes (XX).



A male body cell has one X chromosome and one Y chromosome (XY).



Where do body cells get their sex chromosomes? The facing page tells the story.

HOW MALE GAMETES DETERMINE SEX

Let's go back to the idea of meiosis (Aim 19). Meiosis produces gametes (sex cells) from special body cells.

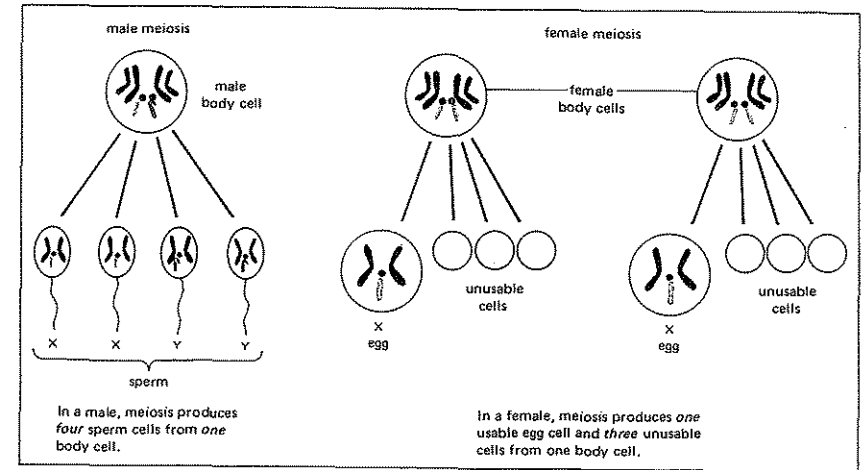


Figure A

How egg and sperm cells are produced in fruit flies

Gamete chromosomes are not paired. They are single chromosomes. A gamete, then, has half the number of chromosomes of a body cell. Count them.

Look at the sex chromosome of each gamete.

- An egg has an X chromosome only.



- A sperm may have an X or a Y chromosome, 50 percent have an X chromosome; 50 percent have a Y chromosome.



Now here is where chance comes in.

- If an X sperm fertilizes an egg (X + X), the offspring will be a female (XX).



- If a Y sperm fertilizes an egg (Y + X), the offspring will be a male (XY).



Male or female? The chances are 50-50. See for yourself in Figure B.

	X SPERM Y	
EGGS	X	XX XY
	Y	XX XY

Figure B

XX = female - 50 percent
XY = male - 50 percent

Sperm have tails and are able to swim. Millions of sperm may swim toward the same egg. Only one can fertilize it.

Will it be an X sperm or a Y sperm?

It depends upon chance!

1. If an X sperm fertilizes the egg, the offspring will be a _____ male, female.
2. If a Y sperm fertilizes the egg, the offspring will be a _____ male, female.

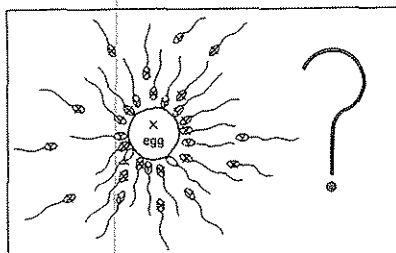


Figure C

The 50-50 chance of male or female birth holds true not only for humans. It holds true for all organisms that reproduce sexually—plants as well as animals.



Figure D

3. Does this hold true for bacteria and molds? _____
Why or why not? _____
4. Does this hold true for fish and frogs? _____
Why or why not? _____

COMPLETING SENTENCES Complete the sentences with the choices below. One of these may be used five times. One of these may be used three times.

chance
female
Y

X
half
male

gametes
50-50

1. There are two kinds of sex chromosomes. They are called _____ and _____.
2. A female body cell has only _____ sex chromosomes.
3. A male body cell has both _____ and _____ sex chromosomes.
4. Meiosis produces _____.
5. A gamete has _____ the number of chromosomes found in a body cell.
6. Eggs have only _____ sex chromosomes.
7. Sperm have either _____ or _____ sex chromosomes.
8. Which will fertilize an egg, an X sperm or a Y sperm? It depends entirely upon _____. The odds are _____.
9. The fertilization of an egg by an X sperm produces a _____ offspring.
10. The fertilization of an egg by a Y sperm produces a _____ offspring.

MATCHING Match the two lists. Write the correct letter on the line next to

1. _____
2. _____
3. _____
4. _____



- a) X chromosome
- b) = male
- c) Y chromosome
- d) = female

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ A body cell has paired chromosomes.
2. _____ A gamete has paired chromosomes.
3. _____ An egg has only a Y sex chromosome.
4. _____ A sperm can have either an X or a Y sex chromosome.
5. _____ An X chromosome looks the same as a Y chromosome.
6. _____ Many sperm fertilize one egg.
7. _____ Fertilization by an X sperm produces a female.
8. _____ Fertilization by a Y sperm produces a male.
9. _____ More X sperm fertilize eggs than Y sperm.
10. _____ About the same number of male and female plants and animals are born.

FLIP A COIN

Flip a coin 100 times. Count how many times it lands on heads, and how many times it lands on tails.

1. a) How many times did it land on heads? _____
b) How many times did it land on tails? _____
c) Is it about 50-50? _____
2. Is flipping a coin a chance happening? _____
3. What other chance happening did you learn about in this Aim? _____

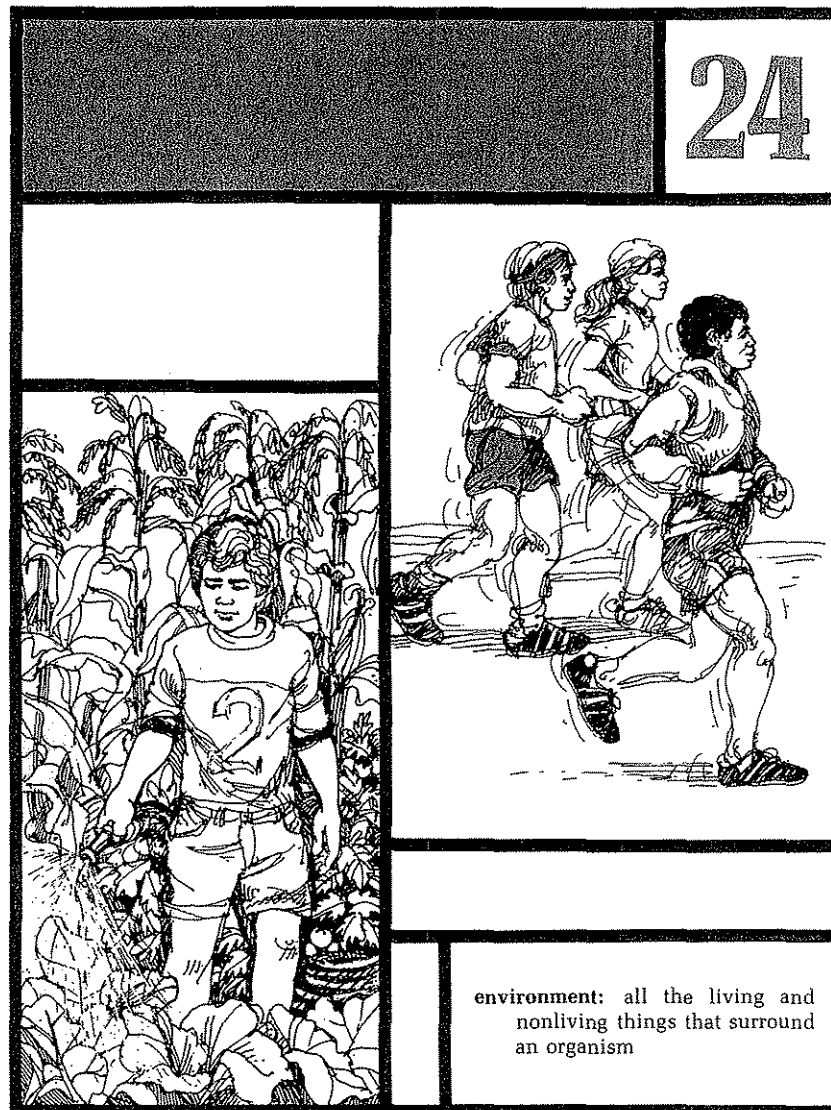
REACHING OUT

It is the *male* that determines the sex of an offspring.

Why? _____

HOW DOES THE ENVIRONMENT AFFECT TRAITS?

24



environment: all the living and nonliving things that surround an organism

AIM | How does the environment 24 | affect traits?

What makes you the way you are? Genes? Of course! But genes do not work alone. Environment is also important.

The environment is made of all the living and non-living things that surround an organism. Air, water, temperature, and food are all parts of the environment. The right combination of these things is needed for an organism to develop properly.

Green plants, for example, need an environment of proper sunlight, water, and minerals to grow well. In a poor environment, they grow small, weak, and pale.

A person may have the genes for growing tall. But poor diet may prevent full growth.

Diet is just one part of your environment. There are many other things that make up your environment. Can you name some?

We cannot change our genes. But, we can change some parts of the environment in which we live. Eating, resting, and exercising properly help the traits we are born with develop to their fullest.

WHAT DO THE PICTURES SHOW?

Traits need a proper environment to develop properly.

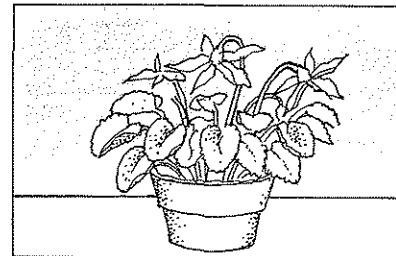


Figure A

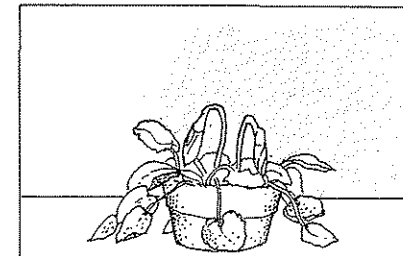


Figure B

1. In which figure do you see a plant that grew in a good environment? _____
2. How can you tell? _____
3. In which figure do you see a plant that grew in a poor environment? _____
4. How can you tell? _____

These two rats were born in the same litter. One ate a poor diet. The other ate a diet rich in nutrients.



Figure C

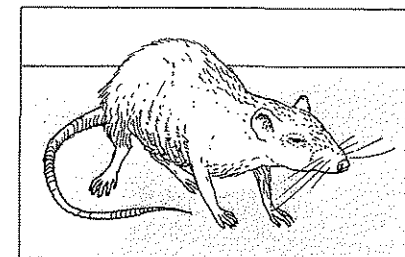


Figure D

5. Is diet part of a living thing's environment? _____
6. Which figure shows a rat that ate a poor diet? _____
7. How do you know? _____
8. Which figure shows a rat that ate a good diet? _____

9. How do you know? _____

10. In your own words, what does environment mean? _____

ARE ALL TRAITS INHERITED?

Many traits are not inherited.

They develop because of changes in the environment. These traits are called acquired traits.

Here are some examples of acquired traits.

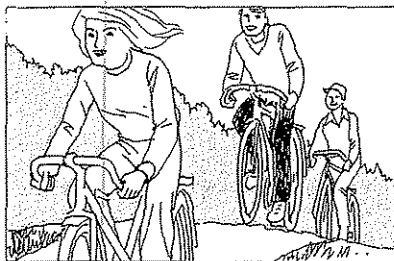


Figure E
Some people develop strong muscles by exercising.

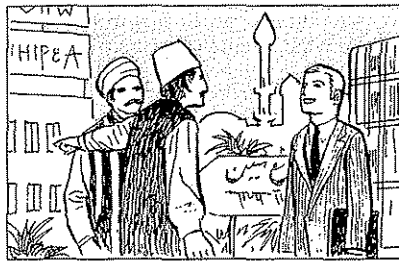


Figure F
Some people learn to speak many languages.

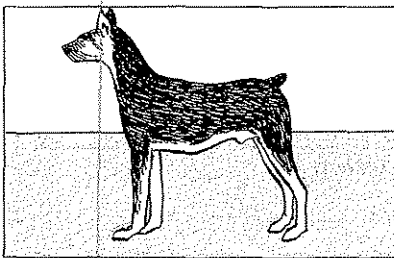


Figure G
The tails of some dogs are cut off at birth.



Figure H
Trees near the tops of mountains do not grow tall partly because of low temperatures.

What do you think? Can acquired traits be passed on to an offspring? In other words, can acquired traits be inherited? Answer this question yourself.

1. If parents develop strong muscles by exercising, will their children inherit strong muscles? _____
yes, no

2. Suppose you have learned to speak a new language, will your children be born with this ability? _____
yes, no

3. Suppose the dog in Figure G has puppies. Will they be born without tails? _____

4. Conclusion: Acquired traits _____ inherited.
are, are not

5. What kind of traits do you think are inherited? _____

COMPLETING SENTENCES

Complete the sentences with the choices below.

living
acquired
genes

traits
nonliving

inherited
environment

1. The characteristics of an individual are called _____.
2. Inherited traits are passed on to offspring by _____.
3. Traits develop properly only in a proper _____.
4. The environment includes all the _____ and _____ things surrounding an organism.
5. Traits that develop because of a change in environment are called _____ traits.
6. Generally, acquired traits are not _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | | |
|----------|------------------------------|---|
| 1. _____ | acquired traits | a) not inherited |
| 2. _____ | environment | b) genes |
| 3. _____ | proper environment | c) everything surrounding an individual |
| 4. _____ | carriers of inherited traits | d) best for developing traits |

TRUE OR FALSE Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ Every trait is carried by genes.
2. _____ Every trait is inherited.
3. _____ A trait that is not carried by genes is an acquired trait.
4. _____ Offspring inherit the acquired traits of their parents.
5. _____ Environment affects how traits develop.
6. _____ Traits develop best in a poor environment.
7. _____ We can control part of our environment.
8. _____ You can inherit genes for strong muscles
9. _____ Exercise can make strong muscles even stronger.
10. _____ Extra-strong muscles developed by exercise can be inherited.

HOW DOES KNOWING ABOUT GENETICS HELP US?

25



breeding: the selective mating of plants and animals to improve certain traits

mutation: a sudden, accidental change in genes

AIM | How does knowing about 25 | genetics help us?

You have probably eaten corn on the cob. Have you ever eaten an ear of corn that is only as long as your thumb? Perhaps you have. But, usually we think of corn as a large-sized vegetable.

Tiny ears of corn were all that existed thousands of years ago. But the Indians in South and Central America changed that. They noticed that in nature some ears of corn were larger than others. So by mating the plants with the largest ears, they found that the offspring were likely to have large ears, too. Over many years of *selecting* only the seeds from largest ears to reproduce, the size of corn ears greatly increased.

Mating animals and plants to produce certain traits is called *breeding*. People have bred animals and plants long before they knew about chromosomes and genes. And with our present knowledge of genetics, even more changes can be made.

Breeding helps supply the hungry world with food. Plants can be bred to produce larger and better crops. Animals can be bred to produce better meat, milk, and wool.

Breeding also serves special needs. For example, breeding has given us giant flowers with unusual colors and furs with attractive sheens. We now have faster racehorses. Even dogs are bred for special jobs.

Scientists breed plants and animals in laboratories. There, chromosomes can be studied under powerful microscopes. The experiments done on laboratory animals and plants have led to many discoveries. Scientists can now detect and control certain diseases. Our knowledge of how traits are passed on has certainly increased from Mendel's day.

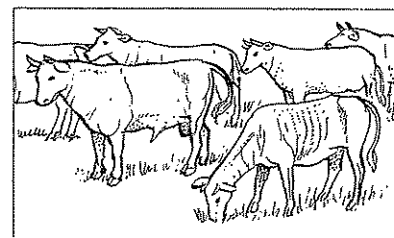


Figure A Selection

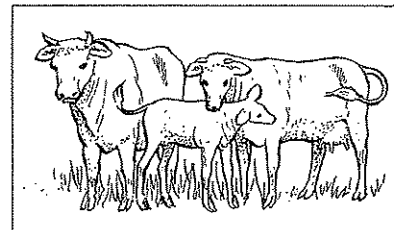


Figure B Inbreeding

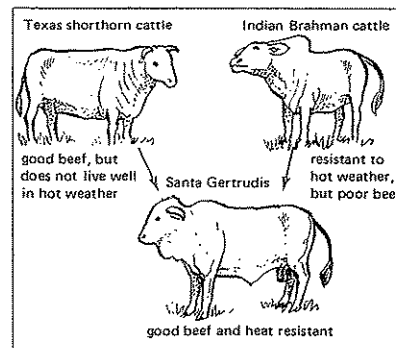


Figure C Cross-breeding

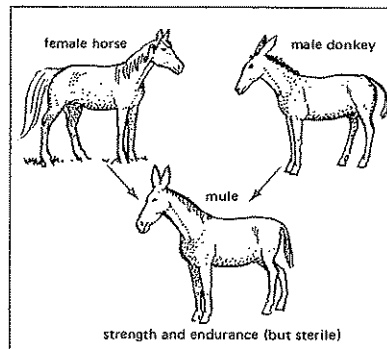


Figure D Wide Crosses

BREEDING

Figures A through D show methods of breeding. Look at each figure and answer the questions.

The plants and animals with the desired traits are selected for reproduction.

Closely related individuals are mated. This is called *inbreeding*. The offspring are likely to have the desired traits.

Sometimes related, but different, breeds of animals or plants are mated. This combines desired traits.

1. What kind of climate do you think the Indian Brahman came from?

2. a) If you were a cattle rancher, which breed would you want?

b) Why?

Sometimes two different *species* of plants or animals are mated. This can also combine desirable traits. Usually the offspring are *sterile* [STER il]. They are unable to reproduce.

3. Are mules able to reproduce?

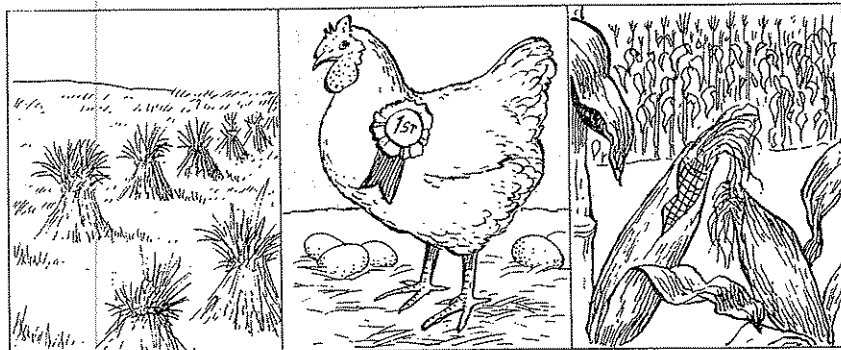


Figure E

Breeding animals and plants helps increase production.

4. Why is greater production important to world population? _____

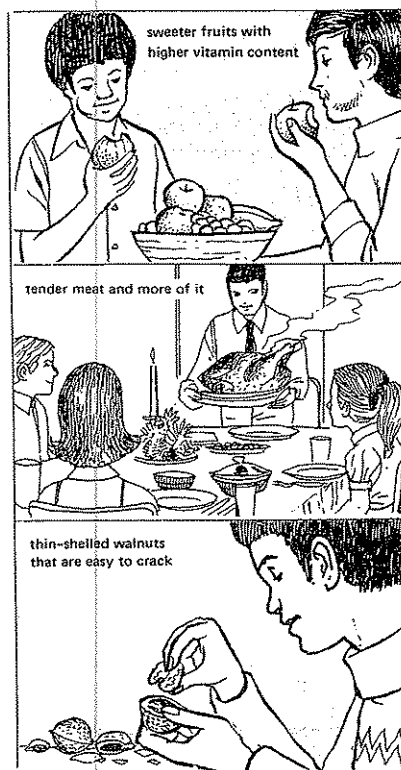


Figure F

Breeding improves quality and gives us plants and animals with special traits.

5. a) Do you think that the food you eat is the same as the food people ate a hundred years ago? _____

b) Why or why not? _____

MUTATIONS

A mutation [myoo TAY shun] is a sudden change in genes. A mutation is an accident. It can cause new inherited traits.

Most mutations occur in nature.

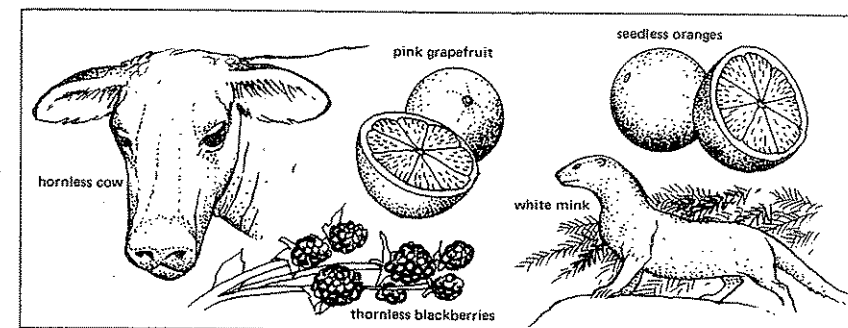


Figure G Some familiar mutations

Scientists can also cause mutations in the laboratory with radiation.



Figure H

The Mediterranean fruit fly damages fruit.

Some male insect pests, like the Mediterranean fruit fly, are given radiation. The radiation causes many changes in the genes. The genes become damaged. With damaged genes, the male flies are sterile.

When the flies mate, no offspring are produced. The insect population is reduced. This is a way of reducing insect pests without harmful chemicals.

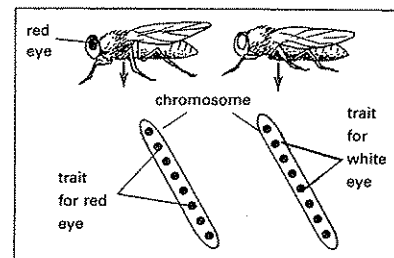


Figure I

White eyes is a mutant trait in fruit flies.

Mutations helped scientists make a "map" of the chromosomes of the fruit fly.

A chromosome map shows which part of the chromosome controls which trait.

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Every farm acre grows the same size crop.
2. _____ Every cow gives the same amount of milk.
3. _____ Breeding is controlled reproduction.
4. _____ Breeding helps increase our food supply.
5. _____ In breeding, the best animals are selected for reproduction.
6. _____ Breeding passes on desirable traits.
7. _____ All wheat plants are the same.
8. _____ Breeding can develop animals that resist heat.
9. _____ All mutations are bad.
10. _____ Chromosomes may be mapped.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-------------------------|---|
| 1. _____ mutation | a) mating only close family members |
| 2. _____ inbreeding | b) mating related, but different breeds |
| 3. _____ selection | c) sudden change in genes |
| 4. _____ cross-breeding | d) mating different kinds of animals |
| 5. _____ wide crosses | e) only the best will reproduce |

REACHING OUT

Mendel worked with pea plants. Later on, scientists worked with fruit flies. Now, scientists use bacteria and viruses to learn about genetics. Why is it difficult to study humans?
